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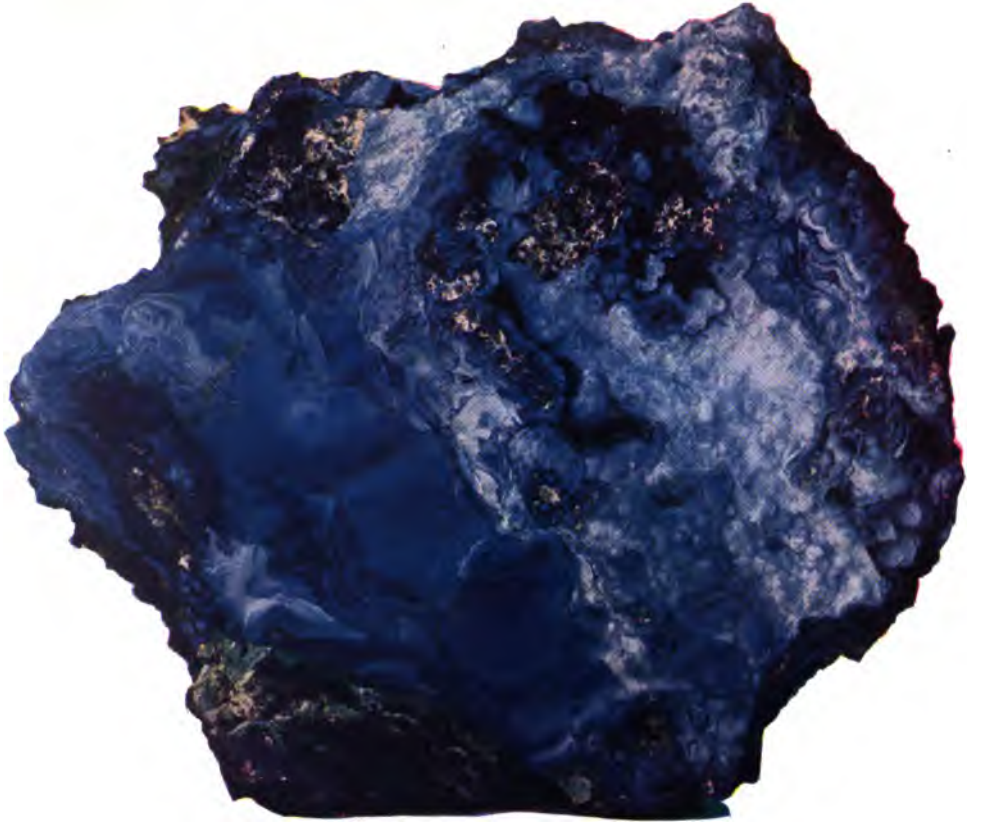

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Under the direction of

LEWIS E. AUBURY,

State Mineralogist.

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LETTER OF TRANSMITTAL.

To His Excellency JAMES N. GILLETT, *Governor of the State of California, and the Honorable the Board of Trustees of the State Mining Bureau.*

GENTLEMEN: I have the honor to transmit to you Bulletin No. 50, "Copper Resources of California."

This report is a revision of Bulletin No. 23, "Copper Resources of California," which was published in 1902 by this department. Owing to the immense development in copper mining which has taken place in this State since the latter Bulletin was published, it has been considered advisable to bring this publication up to date, and furnish all possible information on developments in copper for the past six years.

I have endeavored to incorporate descriptions of all copper prospects and mines in this Bulletin. On occasions, it has happened that when field assistants visited certain properties, no one was to be found, and therefore access was not possible, and no information could be obtained. Where the field assistants visited properties, we have to report that they were invariably treated with the greatest courtesy by mine owners and superintendents, and I wish to extend the thanks of this department for the assistance rendered to them.

Engaged as field assistants who collected data for the revision of "Copper Resources of California" were Dr. A. Hausmann, who visited the counties of Siskiyou, Del Norte, Trinity, Shasta, and Humboldt in the north, and his assistant, Mr. J. Kruttschnitt, Jr., who carried on a portion of the work in Shasta and Siskiyou counties. Dr. Hausmann also reported upon the mines in San Bernardino, Inyo, Calaveras, Amador,

Tuolumne, Mariposa, Madera, and Fresno counties. Mr. W. E. Thorne was engaged in field work in Placer, El Dorado, and Nevada counties. Mr. J. A. Edman reported on new discoveries in Plumas County.

Thanks are due and are cordially extended to all of those who have in any way assisted in the preparation of this Bulletin.

Respectfully submitted.

LEWIS E. AUBURY,
State Mineralogist.

November 1, 1908.

THE
COPPER RESOURCES OF CALIFORNIA.

CONDITION OF THE INDUSTRY.

Copper occupies the place of third importance in the annual record of California's mineral production, and with an output of 32,602,945 pounds, valued at $6,341,387 in 1907, California is the fifth copper-producing state of the Union. The total production for the last twenty-one years from 1887 to 1908 was 291,739,742 pounds, valued at $44,034,008, more than 16¾ cents a pound. While Michigan, Montana and Arizona greatly exceed this output, the figures of the world's production show that this State will undoubtedly soon assume a much larger importance as a copper field and that it will long remain a strong factor in the industry. The copper industry is an old one in California. Many thousands of tons of rich ores were shipped for reduction from San Francisco to the Atlantic coast and Europe between 1861 and 1886; but thereafter, for many years, the industry remained at a low ebb, and copper was one of the minor mineral products of the State. In 1896 came the discovery of the possibilities of the large copper belt in Shasta County, the result of the reopening and successful operation of the mine of the Mountain Copper Company in Iron Mountain. This mine soon took high rank among the great copper mines of the world. The further exploitation of the Shasta copper belt soon followed the early success of the Mountain Copper Company, and in 1901 a great property, the Bully Hill, entered the field as a producer, equipped with a modern smelting plant.

Since then a number of other mines have developed into great producers, the most important being the Mammoth, the Balaklala, and the Afterthought. Mines of sufficient magnitude to have their own reduction works are further, the Penn

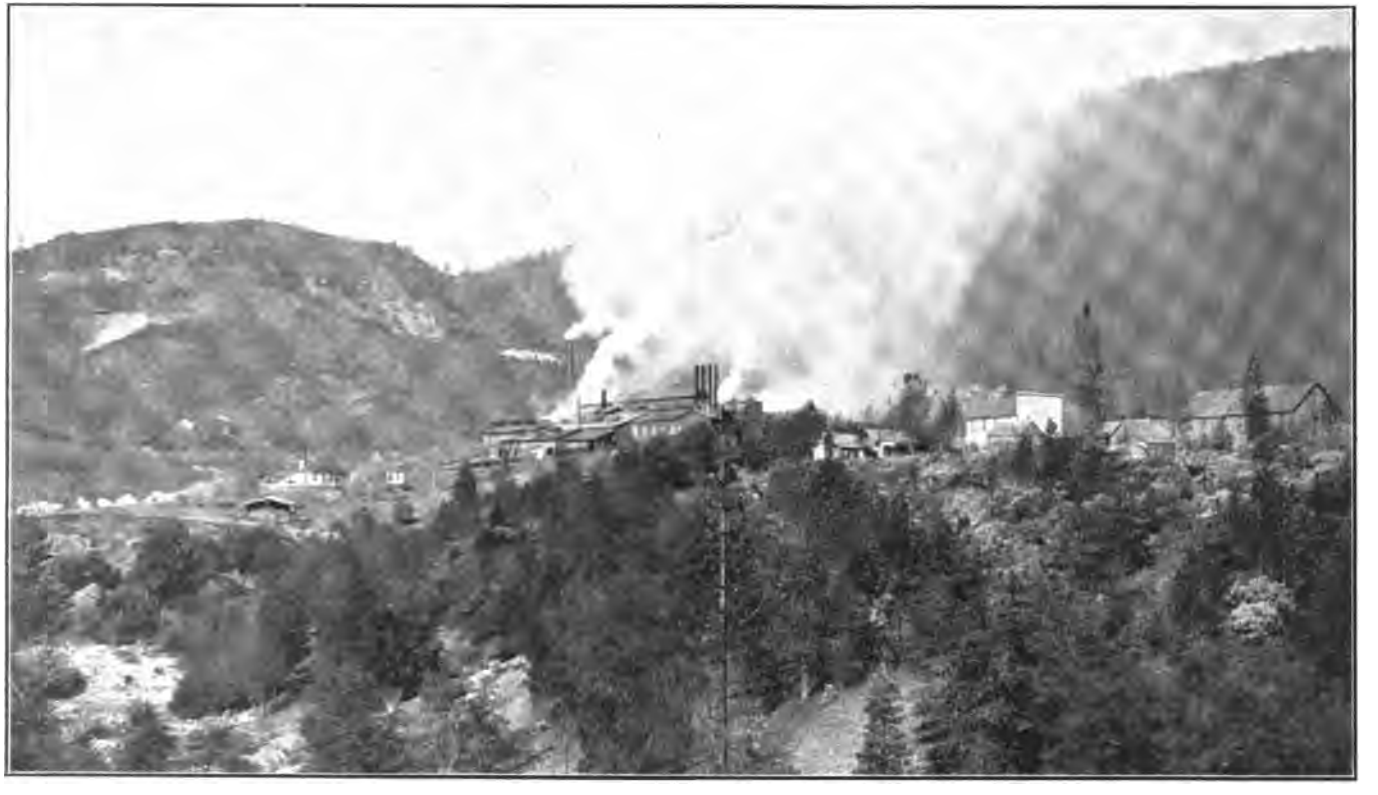
Chemical Company and the Union Copper Mining Company, both in Calaveras County, and there are many old mines on which operations have been resumed lately and some new discoveries which promise to contribute largely to the State's copper production in the near future. California copper resources thus command interested attention at the present time, not only because of their relation to the material prosperity of the State, but because of their wider significance as a comparatively new and very important source of the world's copper supply.

California's copper deposits have a remarkably wide distribution, being scattered over the length and breadth of the State and occurring in practically every one of its fifty-eight counties. Thousands of deposits have been subjects of mining locations at different times, and hundreds have yielded at least a few tons of merchantable ore as a result of superficial prospecting. There is hardly a county in the State which has not at some time made at least such small contributions to the copper supply. Such deposits, usually small as far as revealed by slight development, are scattered at varying intervals along the borders of the State and throughout every section of it, except in the detrital deposits of the valleys.

The deposits of economic importance, however, are mainly concentrated in certain belts and districts which require chief consideration. For convenience, the copper deposits of the State are in this bulletin grouped in four geographical divisions: Shasta County; the Coast Range; the Sierra Nevada Range; and the general arid region of southeastern California.

The leading copper district of California, and the one that promises to remain of overshadowing importance for a good while in the future, in total output of metal, is that of Shasta County, in the north-central part of the State. Here is a series of copper deposits forming a curved belt nearly 30 miles long, and a copper district which must soon rank with the few great individual copper districts of the world.

Of second importance is the copper belt of the western slope of the Sierras, which in territorial magnitude is not rivaled in the world. Here is an almost continuous series of copper deposits stretching north and south for about 400 miles. In this belt the principal copper mines of the State in former



BULLY HILL MINES AND SMELTER, SHASTA COUNTY.

years were developed, and along it there will undoubtedly be many producing mines developed in the future.

While the Coast Range displays copper deposits throughout its length of 500 miles, its important copper districts are in its northern portion, extending for about 150 miles southward from the Oregon line. Except in Del Norte County, in the northwestern corner of the State, where several mines were productive of considerable quantities of shipping ore nearly forty years ago, the deposits of this range have not been developed beyond the most superficial prospecting in a few instances, but surface indications point to the widespread existence of cupriferous veins of sufficient size and value to warrant development and the expectation that this great mineral region will include profitable copper mines among its industries.

Many copper deposits are widely scattered throughout Southern California, especially through the mineralized desert region of the southeastern part of the State. These deposits much resemble those of Arizona in their character.

THE COPPER ORES.

The principal commercially useful copper ores found in California are the sulphides, carbonates, and silicate of copper. The most common of these, and the one that may virtually be found throughout the entire mineral belt of California, is

Chalcopyrite.—Sometimes designated as copper pyrite. This mineral is a double sulphide of copper and iron, of a brass yellow color, giving a greenish-black streak. It has a hardness of 3.5 to 4 in the mineral scale, and a specific gravity of 4.1 to 4.3, with a metallic luster which is sometimes tarnished, showing iridescence. It is usually auriferous and argentiferous. It is found, both in crystal form and massive, in gneiss, crystalline schists, serpentine, etc., associated with iron pyrite, zinc blende, quartz, calcite, and barite (heavy spar). It is composed, when pure, of copper 34.6, iron 30.5, and sulphur 34.9.

Bornite.—Also known as erubescite, horseflesh ore, peacock ore; is, like the former, a double sulphide of copper and iron,

ROASTING STALLS FORMERLY USED BY THE MOUNTAIN COPPER COMPANY, KESWICK, SHASTA COUNTY.

of a metallic luster, with a purple red to pinchbeck brown color on a fresh fracture, tarnishing speedily to iridescence. It gives a pale grayish-black streak. It has a hardness of 3 and specific gravity of 4.9 to 5.4; and contains copper 55.5, iron 16.4, sulphur 28.1. It has been found in Plumas, Fresno, Shasta, Santa Clara, Calaveras, and Inyo counties.

Chalcocite.—Copper glance; is a sulphide of copper, of a dark lead-gray color, often green on the surface, with a metallic luster and blackish lead-gray streak, often tarnished blue or green. The hardness is 2.5 to 3, and specific gravity 5.5 to 5.8. It contains 79.8 copper and 20.2 sulphur, with sometimes a little iron and silver replacing part of the copper. It has been found in Inyo, San Bernardino, San Diego, Los Angeles, San Luis Obispo, and Plumas counties.

Covellite.—Is a cupric sulphide, of an indigo blue or darker color, with a lead-gray to black shining streak, and submetallic luster when crystalline, but dull when massive. The hardness is 1.5 to 2, and specific gravity 4.59 to 4.63. It contains 66.4 copper and 33.6 sulphur. This ore is the result of alteration from other copper ores, especially chalcocite. It has been found in a few localities in California.

Azurite.—Is a hydrous carbonate of copper, of an azure blue color, vitreous luster and a light blue streak. The hardness is 3.5 to 4, and specific gravity 3.77 to 3.83. It is transparent to subtranslucent. This is a valuable copper ore, and is found in Calaveras, Inyo, and Monterey counties. It carries 69.2 copper oxide, 25.6 carbonic acid, and 5.2 water.

Malachite.—Is the green carbonate of copper; the color is bright green, giving a pale green streak; the hardness is 3.5 to 4, and specific gravity 3.9 to 4. It is found commonly massive, but also incrusting, with a delicate fibrous silky structure. It contains 19.9 carbon dioxide, 71.9 cupric oxide, and 8.2 water. It is a valuable copper ore, and when found massive is used for ornamental purposes. It is found in numerous parts of California, but hitherto not massive.

Cuprite.—Red oxide of copper; is an oxide of copper of various shades of red, from cochineal red to almost black. It

MOUNTAIN COPPER COMPANY'S ORIGINAL SMELTER PLANT, KESWICK, SHASTA COUNTY.

has an adamantine or submetallic to earthy luster, and a brownish red, shining streak. The hardness is 3.5 to 4, and specific gravity 5.85 to 6.15. It contains 88.8 copper, 11.2 oxygen, and is a common mineral in California, having been found with native copper in Del Norte and Plumas, also near St. Helena in Napa County, farther in Kern, Tulare, Shasta, Mono, Colusa, Placer, Trinity, and Nevada counties.

Native Copper.—This is pure copper, containing often some silver, bismuth, mercury, etc. The color is copper red, giving a metallic shining streak, and showing a metallic luster. It has a hardness of 2.5 to 3, and a specific gravity of 8.8 to 8.9; and is found rather sparingly in California accompanying the various other copper ores, especially in the vicinity of igneous rocks, although it is also found in clay slates and sandstones. It has been found in Calaveras, Plumas, Amador, Napa, and Shasta counties.

Chrysocolla.—This mineral is a silicate of copper, with an opal-like or enamel-like texture. It varies in color, passing from a mountain green and bluish green to sky and turquoise blue; if impure, it may be brown to black. It has a vitreous, shining luster, and the streak (when pure) is white. The hardness varies from 2 to 4; the specific gravity is 2 to 2.238. As it is an alteration product, it is found in connection with other copper minerals, more especially in the southern portion of the State, though very handsome specimens have been found in Plumas County. It contains 45.2 copper oxide, 34.3 silica, and 20.5 water. It is a good copper ore.

Among the less frequent copper ores found in California we may note:

Melaconite.—Black oxide of copper. It is formed by decomposition of chalcopyrite and other copper ores. It is found earthy black, massive, with a specific gravity of about 5, and consists of 79.8 cupric oxide and 20.2 oxygen. It has been found in Calaveras, Shasta, and Kern counties.

Chalcanthite.—This is a native sulphate of copper (blue vitriol), and results from decomposition of copper sulphides. It occurs usually as an efflorescence in old copper mines. It

has been found in California in the Peck mine, Shasta County; also in Nevada County.

Tetrahedrite.—Gray copper ore (fahlore). This mineral has a gray to iron-black color and streak, with metallic luster, a hardness of 3 to 4.5, and a specific gravity of 4.4 to 5.1. It contains 23.1 sulphur, 24.8 antimony, and 52.1 copper. The antimony is sometimes replaced by arsenic, when the ore is named Tennanite. These ores frequently carry some silver.

WHAT CONSTITUTES A GOOD "COPPER SMELTING ORE"?*

The discovery of a mine is in itself not always equivalent to success, for the mere possession of an ore body in the ground is not a source of revenue, and unless the next important question has been solved, how to convert it into money, there may be thousands or millions of dollars worth of ore exposed, not bringing revenue, but causing the loss of money. The reason for such an apparently contradictory condition is, that all the useful metals, with the partial exception of gold and platinum, occur as a rule, not in a native state, but as ores, *i. e.* chemically combined with other elements with which they form new bodies, having but little resemblance either in appearance or quality with the metallic constituents of which they are composed.

Iron, for instance, is found combined with oxygen as a brown earthy substance; a little sulphur converts the white, silvery, liquid mercury into the bright red, solid cinnabar; lead forms with molybdenum and oxygen transparent yellow crystals, with oxygen and carbon white crystals of brilliant silky luster, etc. These elements unite in certain fixed proportions, according to certain laws of affinity and may be separated again under the same laws. On the knowledge of these laws is based the science of metallurgy, the art to produce the metals from their compounds in a form in which they can be used in the industries, which also includes the preliminary mechanical work frequently required to separate the ore from the bulk of the baser material in order to obtain it sufficiently pure for treatment.

* By Dr. A. Hausmann.

Although metals have been produced in prehistoric ages, metallurgy has developed in very recent times only from an empirical custom to an exact science, which has greatly modified the processes and increased their efficiency. In no other branch of industry does financial success depend to such an extent on the practical application of theoretical knowledge (which is really nothing else but a systematically arranged collection of facts obtained by experience), as in metallurgy. While it is possible under certain conditions to obtain good results by mere practical methods, such work as is done by large modern smelters, would be impossible without the scientific basis, which permits of calculating the results in advance with absolute certainty, leaving nothing to chance and accident. Notwithstanding many practical demonstrations that these metallurgical calculations are indispensable for financial success, the necessity of scientific methods is still too often ignored and this disregard causes frequent failures, involving great financial losses, to the detriment of the mining industry, which is usually blamed instead of individual incompetence.

Idle reduction works, mills, smelters, etc., form a conspicuous and unpleasant feature of many mining camps in the United States, representing a deplorable loss of money. The failure of these plants is usually due to these causes: lack of ore, or character of ore, which renders it unfit for treatment in that particular plant, but at the present state of metallurgy, there is no excuse for such failures. A striking example of this kind is the case of the Fresno mine, where, with thousands of tons of ore on the dump and exposed in the mine, its value seems to have been unknown. On the supposition that it contained 7 per cent copper, a smelter was built at a cost of several hundred thousand dollars, but after it was finished it was suddenly discovered that the ore only contained 2 per cent copper and was too low grade for smelting. The smelter was never blown in.

Another very common mistake is to figure on the composition of the ore as it appears on the surface, without taking into consideration the almost certain change taking place in depth. This applies especially to gold veins which carry free milling ore on the surface, the result of exposure to the air, which oxidizes the base metals and liberates the gold. Without ascer-

taining how deep this free milling ore extends, a mill is put up which works all right as long as this ore lasts, but when it changes into sulphide, it is no longer free milling and operations have to be suspended.

For copper ores smelting is almost the only treatment to be considered; it is applicable to all of them without exception, although they are not equally well adapted to it. The question of smelting at the mine is of greater importance for copper than for gold or silver ores, because the former can never attain such high values as the latter. While gold and silver ores may carry metal enough to be worth many thousands of dollars and bear considerable expense for transportation, a ton of 20 per cent copper ore at 30 cents a pound of copper is worth $120 only; but such a grade and price are rather exceptional and 10 per cent ore, copper at 15 cents, in many localities would not pay to ship. Large bodies of copper ore are, however, usually of much lower grade, and the owner is confronted by the alternative to close the mine or to smelt the ore on the spot. In such a case it is of importance to know whether this can be done, and it may not be out of place to state briefly the conditions for successful smelting.

The first condition is, of course, a sufficient percentage of copper, assuming an ore not containing enough gold or silver to affect the value. There is a lowest limit, but no fixed standard for all places; it may be possible in some localities to treat ore as low as 2 per cent, while in others 10 per cent may not be of sufficient grade. Supposing the ore to be of fair grade, the cost of smelting can be calculated if the factors by which it is determined, the cost of fuel, labor, power, fluxes and transportation, are known, but it requires knowledge of smelting and the chemical composition of the ore and presents a problem which the metallurgist must solve for every particular case and locality. Often we hear people speak about self-fluxing ore who evidently do not know what constitutes this desirable quality, and for the better understanding of this important question a general idea of the principles involved is given.

The object of smelting is the separation of a metal from the material with which it is mechanically mixed or chemically combined, and this is accomplished by uniting the necessary minerals in such proportions that they will smelt and form

liquids (slags) of less specific gravity than the metal, which they permit to sink through and gather on the bottom. If the metal is not present in the ore as such, it is either converted into the metallic state by the chemical action of the flux and fuel, or recovered in some form which requires subsequent treatment or refining. But the principle of separation by specific gravity remains the same, and the more or less perfect recovery of the metal depends on the proper condition of the slag. Because the metal represents a small portion of the ore, the making of a slag free from metal and easily removed is the main object of the metallurgist. The material forming the slag consists of two groups, the acid silica (quartz) and the basic, the oxides of the heavy metals, iron, manganese, etc., and the earthy bases, lime, magnesia, etc., which must be combined in certain proportions in order to answer the purpose for which slags are made, because they are infusible by themselves. Silica, iron, and lime furnish the bulk of the slag-making material in copper ores and the basis for the slag calculation. Silica requires a certain quantity of the basic group, which may be iron, manganese, lime, etc., but experience has shown that the oxides of the heavy metals, iron, etc., must be replaced to a certain extent by the earthy oxides, lime, etc., in order to reduce the specific weight of the slag sufficiently to allow the metallic particles to sink and collect. Taking a slag, for instance, consisting of 30 per cent silica, 40 per cent ferrous oxide and 20 per cent lime, the latter might be partly replaced by magnesia, alumina, etc., in various proportions, and their amount total may also be diminished, necessitating an increase of iron at the same time, but it would not be safe to go below a certain limit, about 10 per cent, because the slag would become too heavy. The ideal self-fluxing ore, therefore, would be an ore containing the acid and basic constituents in such proportions as required to make a good slag and which could be smelted without adding any fluxes. Such an ore is seldom found in practice; the metallurgist is content with an ore requiring fluxes that can be cheaply procured and which is free from impurities interfering with the smelting. As such must be named arsenic and antimony, heavy spar, galena and, worst of all, zinc, which becomes prohibitive if exceeding about 10 per cent of the charge.

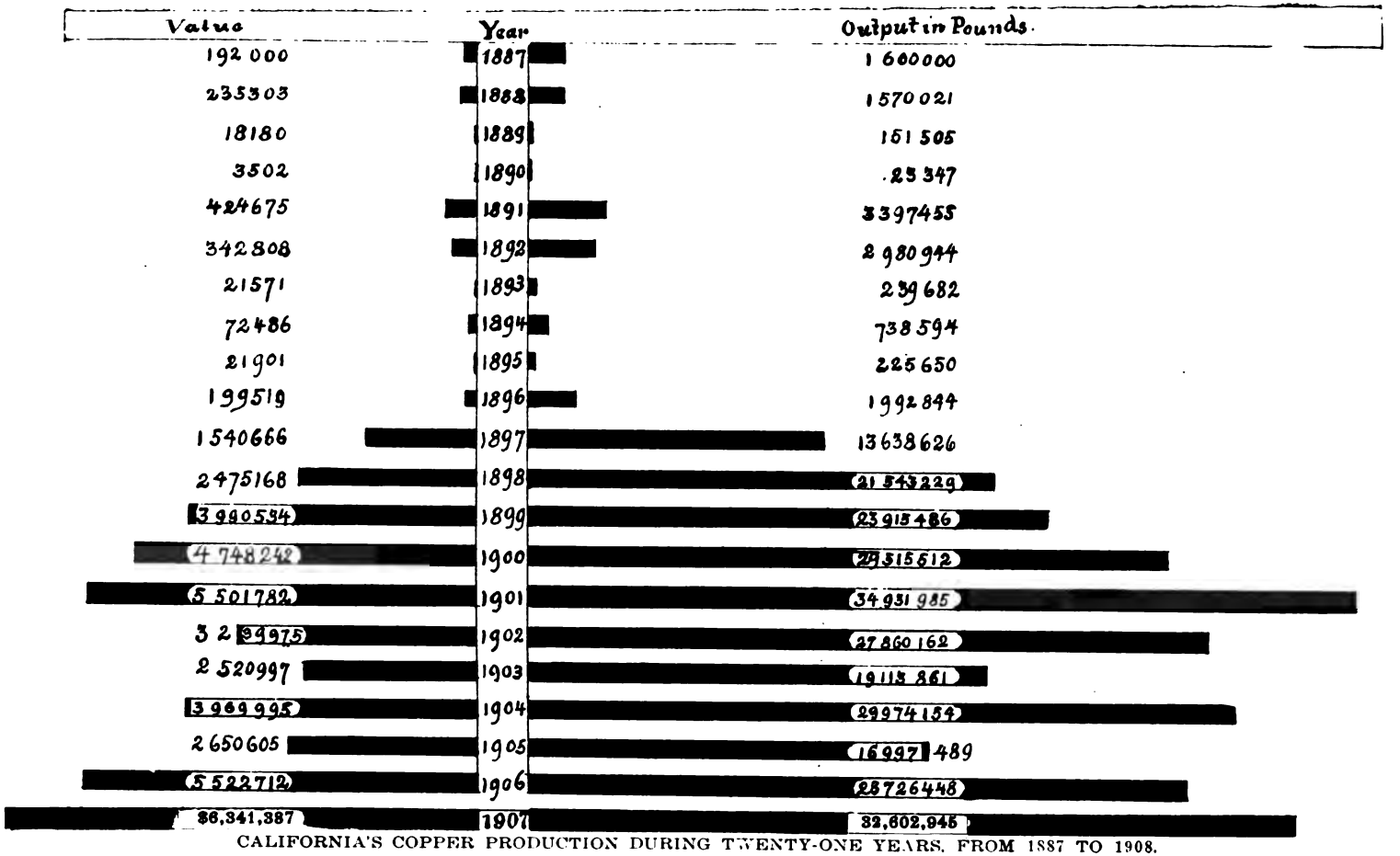
According to the character of the ore, we distinguish between the smelting of oxidized ores, intending to produce metallic copper directly, and the smelting of the sulphide ore, producing an intermediate product, matte. Oxidized ores are not as common as the sulphides; they are usually confined to the upper part of a vein and the probability of changing into the latter at a certain depth, usually below the water level, must be taken into consideration when the erection of a smelter is planned.

By far the greater part of the copper produced is obtained from the sulphides, not in metallic form, but as a mixture of sulphides, called matte. By making this product it is possible to smelt ores that contain only 3 per cent copper (or even less) and obtain a matte rich enough (45 per cent or over) to extract the metal by a different process. Matte smelting is really a dry concentration, by which the silica and the earthy constituents of the ore and part of the excess of sulphur and iron are removed, condensing the copper contents into a smaller bulk in various proportions, at a ratio of from 3, 10, or even 20, into one. There are two ways to accomplish this object, the old method of matte smelting, in which part of the sulphur is removed by preliminary roasting and the residue smelted with the addition of fluxes and fuel, and the later method, called pyritic smelting. In this method the ore is smelted without roasting, utilizing the heat from the burning sulphur, adding only a very small percentage of carbonaceous fuel. It is evident from the foregoing brief description of the principles of smelting that a definition of what constitutes a good smelting ore can only be given in a general way; it is an ore which is free from injurious minerals and contains silica and the bases in a proportion required for a good slag, without the addition of either one of them, as flux. Whether a certain ore can be smelted with profit in a given place, depends to such an extent on local conditions that the problem has to be solved for every particular case. The smelting of copper to-day is such an exact science that every result can be calculated in advance, and there is no longer any excuse for failure in an enterprise of this kind.

STATISTICS.

The oldest consecutive record of the copper production of California having the stamp of official authority begins with 1882, when the United States Geological Survey began its mineral statistics. "Mineral Industry" began its annual mineral record with 1892. The California State Mining Bureau's careful yearly compilation of the amounts and values of the State's mineral products began in 1894. There are radical disagreements between the records of the U. S. Geological Survey and those of "Mineral Industry" as to some of the years succeeding 1891, and between these records and that of the State Mining Bureau as to some of the years succeeding 1893. The following statistical record of the copper product of California, in fine pounds, for 1882 and following years, is made up of the record of the U. S. Geological Survey for the years preceding 1894 and of the record of the State Mining Bureau for the succeeding years:

Year.	Fine Pounds.	Year.	Fine Pounds.
1882	826,695	1895	225,650
1883	1,600,862	1896	1,992,844
1884	876,166	1897	13,638,626
1885	469,028	1898	21,543,229
1886	430,210	1899	23,915,486
1887	1,600,000	1900	29,515,512
1888	1,570,021	1901	34,931,985
1889	151,505	1902	27,860,162
1890	23,347	1903	19,113,861
1891	3,397,405	1904	29,974,154
1892	2,980,944	1905	16,997,489
1893	239,682	1906	28,726,448
1894	738,594	1907	32,602,945



CALIFORNIA'S COPPER PRODUCTION DURING TWENTY-ONE YEARS, FROM 1887 TO 1908.

Table Showing the Copper Production of California by Counties for Seven Years from 1894.

Compiled from the Annual Mineral Statistics of the State Mining Bureau.

County.	1894.		1895.		1896.		1897.		1898.		1899.		1900.	
	Lbs.	Value.	Lbs.	Value	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Amador			16,500	$1,650	30,000	$3,000			3,000	$300			220,000	$34,100
Calaveras	654,866	$64,951	175,895	16,925	87,557	8,990	34,000	$3,740	18,400	2,052	165,484	$27,586	980,934	150,585
El Dorado													3,125	500
Inyo									49,829	3,986				
Kern													4,000	750
Madera													500,000	77,500
Nevada	83,728	7,535	33,255	3,325	28,200	2,820	12,000	960	30,000	3,000	43,438	7,084	150,980	20,472
San Bernardino											1,369,878	232,339	1,920,000	297,600
Shasta					1,847,087	184,708	13,592,626	1,535,966	21,442,000	2,465,830	21,385,863	3,565,023	25,736,473	4,166,785
Unapportioned											950,823	158,502		
Totals	738,594	$72,486	225,650	$21,950	1,992,844	$199,518	13,638,626	$1,540,666	21,543,229	$2,475,168	23,915,486	$3,990,534	29,515,512	$4,748,242

Table Showing the Copper Production of California by Counties for Seven Years, from 1901 to 1908.

Compiled from the Annual Mineral Statistics of the State Mining Bureau.

County.	1901.		1902.		1903.		1904.		1905.		1906.		1907.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alameda	13,728	$2,162												
Alpine	8,377	1,319												
Amador	52,000	8,190	130,000	$14,620	10,000	$900	14,000	$1,400	10,000	$1,560	8,648	$1,669	5,300	$1,020
Calaveras	1,701,589	268,000	2,087,501	251,062	2,246,675	297,263	2,592,124	414,399	3,666,810	572,022	5,082,320	956,815	3,941,883	609,208
Contra Costa			31,700	3,645										
El Dorado			2,128	319					160,000	24,960			606	122
Fresno	1,159,672	182,648	3,000,000	345,000			2,500	319	1,440,000	224,640	440,000	88,000	250,000	50,000
Inyo	8,566	1,349	1,100	126	23,450	3,098	25,508	3,252	151,606	23,649	4,145	800	6,779	1,356
Kern	429,248	67,606	235,840	27,122	4,300	559								
Madera	108,430	17,077	18,600	2,139	36,000	4,680	10,300	1,313					1,895	379
Mariposa	191,622	30,180	104,700	11,940	61,627	6,808	11,500	1,466	12,541	1,956				
Merced	79,071	12,453	14,400	1,656	6,000	780	8,900	1,135						
Los Angeles													849	169
Orange													964	193
Riverside													502	100
Mono	1,933	305			1,600	208								
Nevada	39,588	6,235	26,500	3,975	4,500	585							22,082	4,418
Placer	11,200	1,764	3,200	368	4,000	520	600,000	76,500	367,250	57,291	200,000	38,600		
Plumas					1,900	247			1,006	157				
Sacramento	2,007	316												
San Bernardino	50,000	7,875	338,480	41,008	60,400	7,852	169,477	17,270	52,603	8,206	514,031	99,207	514,282	102,856
San Diego									4,808	750			13,246	2,659
Shasta	30,990,781	4,881,048	21,515,887	2,496,781	16,453,409	2,171,497	26,438,145	3,439,974	10,830,865	1,688,614	22,477,304	4,338,121	27,844,364	5,568,873
Siskiyou			200	23									193	39
Stanislaus	79,330	12,494	162,400	18,676	116,000	15,080	7,300	931						
Trinity	4,838	761												
Tuolumne			155,826	17,920										
Unapportioned			31,700	3,645	84,000	10,920	94,400	12,036	300,000	46,800				
Totals	34,931,985	$5,501,782	27,860,162	$3,239,975	19,113,861	$2,520,997	29,974,154	$3,969,995	16,997,489	$2,650,605	28,726,448	$5,522,712	32,604,985	$6,341,387

Copper Production of California for fourteen years, from 1894 to 1908.

Compiled from the Annual Mineral Statistics of the State Mining Bureau.

County.	Product in Fine Pounds.	Value.
Alameda	13,728	$2,162
Alpine	8,377	1,319
Amador	500,248	68,409
Calaveras	23,436,038	3,643,093
Contra Costa	31,700	3,645
El Dorado	165,859	25,901
Fresno	6,292,172	890,607
Inyo	270,983	37,606
Kern	673,440	96,047
Los Angeles	849	169
Madera	675,225	103,088
Mariposa	382,087	52,350
Merced	108,371	16,024
Mono	3,538	513
Nevada	474,271	60,409
Orange	964	193
Placer	1,185,650	175,043
Plumas	2,906	404
Riverside	502	100
Sacramento	2,007	316
San Bernardino	4,989,151	814,213
San Diego	18,054	3,409
Shasta	240,554,804	36,503,120
Siskiyou	393	62
Stanislaus	365,030	47,181
Trinity	4,838	761
Tuolumne	155,826	17,920
Unapportioned	1,460,923	231,903
Totals	281,777,954	$42,795,967

California's Copper Production in 1907, by Counties.

County.	Pounds.	Value.
Amador	5,300	$1,020
Calaveras	3,941,883	609,203
El Dorado	606	122
Fresno	250,000	50,000
Inyo	6,779	1,356
Los Angeles	849	169
Madera	1,895	379
Nevada	22,082	4,418
Orange	964	193
Riverside	502	100
San Diego	13,246	2,659
San Bernardino	514,282	102,856
Siskiyou	193	39
Shasta	27,844,364	5,568,873
Totals	32,602,945	$6,341,387

The Progress of the Copper Industry in the United States, as Shown by the Production by States, in Pounds, in the Years 1890, 1895, 1900, and 1905.

Source.	1890.	1895.	1900.	1905.
Lake Superior	101,410,277	129,330,749	145,461,498	218,999,759
Montana	112,980,896	190,172,150	270,738,489	319,179,880
Arizona	34,796,689	47,953,553	118,317,764	222,866,020
Utah	1,006,636	2,184,708	18,854,726	51,950,782
California	23,347	218,332	28,511,225	16,697,486
Colorado	3,585,691	6,079,243	7,826,949	9,854,174
Wyoming			4,203,776	2,393,201
New Mexico	850,034	143,719	4,169,400	5,638,843
Idaho	87,243	1,425,914	290,163	6,500,005
Nevada			407,535	
All other States	378,840	3,105,036	4,835,642	16,457,982
Totals	255,119,653	380,613,404	603,117,167	870,538,132

Average Annual Price of Lake Copper in New York Since 1860.

Year.	Cents per lb.	Year.	Cents per lb.	Year.	Cents per lb.
1860	22.25	1876	21.00	1892	11.50
1861	19.12	1877	18.62	1893	10.75
1862	25.75	1878	16.50	1894	9.56
1863	32.87	1879	17.12	1895	10.76
1864	46.25	1880	20.12	1896	10.88
1865	36.25	1881	18.12	1897	11.29
1866	31.75	1882	18.50	1898	12.03
1867	25.12	1883	15.87	1899	17.61
1868	23.62	1884	13.87	1900	16.52
1869	23.37	1885	11.12	1901	16.72
1870	20.62	1886	11.00	1902	12.16
1871	22.62	1887	11.25	1903	13.72
1872	33.00	1888	16.66	1904	13.01
1873	29.00	1889	13.75	1905	15.89
1874	23.25	1890	15.75	1906	19.15
1875	22.50	1891	12.87		

Table Showing the Position of Copper among the Principal Mineral Products of the United States in 1906.*

Products Exceeding $10,000,000 in Value.		Quantity.	Value.
Coal, bituminous	short tons	342,874,867	$381,162,115
Coal, anthracite, Pennsylvania	long tons	63,645,010	131,917,694
Pig iron, spot value	long tons	25,307,191	505,700,000
Copper, value New York	pounds	917,805,682	177,595,888
Clay products			161,032,722
Gold, coining value	troy ounces	4,565,333	94,373,800
Petroleum	barrels	126,493,936	92,444,735
Stone			66,378,794
Natural gas			46,873,932
Cement	barrels	51,000,445	55,302,277
Lead, value at New York	short tons	350,153	39,917,442
Silver, commercial value	troy ounces	56,517,900	38,256,400
Zinc, value at New York	short tons	199,694	24,362,668
Lime	short tons	3,197,754	12,480,653
Sand, molding, building, etc.	short tons	31,842,572	11,489,420

Total value of all mineral products in 1906 ..... $1,839,288,540

*Report of the United States Geological Survey.

HISTORICAL NOTES.

The history of the copper industry of California is naturally divided into three periods. The first extended from 1860 to 1868, and was a period of active and widespread development and operation of copper mines, some of them on a considerable scale, and of the shipment of many thousands of tons of copper ores by sea to reduction works at Baltimore, New York, and Boston on the Atlantic coast, and to Swansea in Wales. The second period was one of depression and, in fact, of almost complete prostration, extending from the practical cessation of all development in 1868 to 1895. The third and present period is that beginning with the operations of the Mountain Copper Company in Shasta County in 1895, marked by the discovery and development of the immense ore bodies of the copper belt of Shasta County, and by a general revival of interest in the industry throughout the State as a consequence of the successes won at the north and of the recent period of high prices for the metal.

The widespread occurrence of copper in California had been known for many years before the industry began its productive career, but without attracting more than incidental attention. Old records state that as early as 1840 copper had been noted near Soledad Pass, in Los Angeles County, and that about 1854 the deposits afterward worked there were discovered by a Frenchman named Maris. About 1855 a small deposit of copper ore was found in Hope Valley, Alpine County, by "Uncle Billy" Rodgers, and the specimens from it attracted considerable attention on account of their beauty and richness, but the discovery was soon forgotten. Dr. J. B. Trask, who acted as State Geologist from 1851 to 1854, discovered copper minerals in nearly every county in the State, but his reports thereon appear to have had no influence on the later beginning and progress of copper mining in California.

Available historical material is so fragmentary and often unreliable and conflicting that the actual beginning of the

industry can not be fixed. A valuable and lengthy paper in J. Ross Browne's official report on the Mineral Resources of the States and Territories west of the Rocky Mountains, made in 1867, identifies the beginning with the discovery of the Napoleon mine in Calaveras County, late in 1860, by Hiram Hughes. This is essentially an error, as other records show that several copper mining companies, mainly of Del Norte and Calaveras counties, were incorporated in that year, some of them in the spring. Langley's State Register for 1859 says, in part, regarding the copper resources of the State: "The ore from the vicinity of the Pitt and McCloud rivers, Shasta County, is said to excel in richness the celebrated Arizona mines, and to contain in addition a considerable quantity of gold. Ore of exceeding richness has also been found in different localities in El Dorado County, and a vein on the Cosumnes has yielded over seventy per cent of pure metal. There is a vein of copper on the middle fork of the Cosumnes River, Mountain Township, El Dorado County, now being worked by machinery propelled by water. The mill has three stamps attached, and has so far yielded a handsome return to the proprietors."

The last reference is believed to be to the old Cosumnes mine of that county, which was opened chiefly as a gold mine. The evidence indicates that, at the close of the decade of the fifties, practical attention was just turning to some of the known copper deposits of the State, and that modest plans for their exploration were being quietly formed.

However, that discovery by Hiram Hughes late in 1860 appears, from all historical data here available, to be entitled to the honor of being regarded as the real beginning of the notable period of copper mining that quickly ensued, because it does not seem to have resulted from what had been known or done before, and because the copper excitement of that day was a direct consequence of this and related discoveries. Mr. Hughes, according to J. Ross Browne's report, had lived and mined for gold for some years in the region of his discovery in the Gopher Hills, in the low foothills of the western end of Calaveras County. When the first Washoe excitement broke out he joined the rush to the famous new silver field of Nevada, and later joined the returning procession of the unsuccessful.

His observations of the Comstock lode had awakened his interest in rocks he had often seen near home, and on his return he began prospecting for silver. He found the gossan cap of what became the Quail Hill No. 1 mine, found it rich in gold, and began working it as a gold mine. Soon after he found the gossan of what was soon the Napoleon mine, and finding no gold, sent some of the ore to San Francisco for assay. It was reported to carry 30 per cent copper, and to be worth $120 per ton. A local excitement broke out, the lode was traced and located for a number of miles, and hundreds of claims were staked out.

Among the local people who joined in the search for rich copper ores like those of the Napoleon, were W. R. Reed. Dr. Blatchly, and Mr. McCarty, who in June, 1861, made the important discovery and location of the Copperopolis lode, a few miles east of the Napoleon lode. McCarty had mined and farmed in the Salt Spring Valley for ten years, and in 1852 had sunk a prospect shaft on the lode he now helped to locate. Finding no gold he quit, throwing away rich surface copper ores of what was to be the productive Keystone copper mine. Copper ores had in fact been familiar but worthless rocks to these local miners for many years. The men named located 11,250 feet of the Copperopolis lode, and the Copperopolis mine soon appeared richer than the Napoleon. New life was given the local copper excitement, and more hundreds of claims were staked out along and near the Copperopolis lode for twenty miles.

The copper excitement thus started quickly spread, and in a few months it filled the State, running its course after the natural manner of popular mining excitements, and expanding into adjoining States and Territories. The furor and speculative excitement lasted as such for about two years. Prospectors by hundreds visited Copperopolis, and went home or elsewhere to search for similar ores and formations.

The period of 1862-63 was marked by a speculative mania, the organization of hundreds of copper mining companies, and the wildcat exploitation of slight surface prospects. Copper operators soon realized the fact that money, skill, and legitimate development were necessary to success, and the boom suddenly burst, leaving legitimate mining companies to here and there,

throughout the State to pursue their efforts to make money from the development of mines and the shipment of ores. The following notes concerning the active period of the sixties are furnished by Thomas Price of San Francisco, a metallurgist who has been intimately associated with the California copper industry almost since its inception:

"It was well on in the year 1861 before anything considerable had been done in the development of the newly discovered copper deposits of California, but at this time small shipments were made to Boston and Baltimore, and one small lot was sent to Swansea, Wales, by way of New York. By the spring of 1863 the shipments of copper ore from California to other parts of the United States and to Great Britain had assumed very considerable proportions.

"During this period the most important copper mines were near the towns of Copperopolis, Campo Seco, and Lancha Plana, in Calaveras County, and the principal mines were the Union, Keystone, and Empire. The Union mine, the most extensively developed property in the State, was operated on a very considerable scale for several years, and from it several thousand tons of ore were shipped. The mine was opened up to a depth of something like 600 feet, and the vein of solid pyritic ore averaged about 14 feet in width, assaying from 12 to 25 per cent copper. In depth, however, the vein was found to be considerably mixed with slate, and the grade fell off from 6 to 8 per cent.

"The miners at Campo Seco and Lancha Plana shipped several thousand tons of chalcopyrite ore, but the grade was not as high as in the mines near Copperopolis. Between 1863 and 1869 several hundred tons of ore were shipped from the Napoleon and Quail Hill mines, two mines situated some six miles to the west of Copperopolis. From near the surface to a depth of about 200 feet the ore in the Napoleon averaged 20 per cent copper. The Quail Hill yielded large quantities of carbonates and oxides of copper, and carried, in addition to the copper, considerable gold and silver. Several years after it had ceased to be worked as a copper mine, a forty-stamp mill was erected on the ground and an attempt was made to operate it as a gold and silver property, but the sanguine expectations of the owners were far from realized.

"By stains and other indications the copper belt in Calaveras County can be traced for fully thirty miles, and during the early sixties literally thousands of claims were staked out along its course. There is no doubt but that systematic work would result in the development of many valuable copper properties along this belt, in addition to those now known and in process of exploitation.

"In Amador County, the old Jackson, afterward known as the Newton mine, which was discovered in 1861, yielded, down to a depth of 200 feet, a high grade of chalcopyrite, running from 25 to 35 per cent copper, with small quantities of gold and silver. Several thousand tons of ore were shipped from this mine, most of which went to Great Britain; but as greater depth was attained the grade of ore decreased, and it ceased to pay for shipment under conditions and prices which then prevailed.

"From the Newton mine the copper belt extended north to the Cosumnes River, and near the river a low-grade deposit was opened up, but it proved too poor to stand the expense of shipment. Both Mariposa

and Fresno counties, as then known, produced some copper ore. The Buchanan mine was the largest property in that section, and some hundreds of tons of ore were shipped from it.

"Based upon the early day prospects, Tuolumne, Mariposa, Madera, Merced, Stanislaus, Fresno, and Tulare counties should prove large producers of copper when their resources in this direction shall have received proper attention. The Santa Cruz Mountains yielded several hundred tons of ore in the year 1867.

"Earlier than this considerable very high-grade ore, carrying as much as 48 per cent copper, with 2 ounces of gold and 40 ounces of silver per ton, was shipped from Genesee Valley in Plumas County, the means of transportation being by teams to Marysville and thence by boat to San Francisco.

"During the period extending from 1862 to 1865, Del Norte County ranked second only to Calaveras in the production of copper ore. The largest mine in Del Norte was known as the Low Divide, next to which came the Union, while the Occidental and other mines produced comparatively small quantities of ore. In Del Norte the copper belt extended north and south for a distance of about ten miles.

"The old Zinc House mine, near the Empire ranch, in Nevada County, shipped considerable quantities of high-grade carbonates and oxides, but no large quantities of chalcopyrite, as in the case of most of the mines then shipping. The mine, however, contained large quantities of pyritic ore, but the percentage of copper contained was not sufficient to make it a shipping proposition. Subsequently this low-grade material was very successfully worked by open-air roasting, leaching, and precipitation of the copper on iron.

"In Shasta County copper was discovered and mined at Copper City, then known as Williams, as early as 1862. In 1863 some 250 tons of the ore were shipped to San Francisco, but on sampling it was found to contain only 8 per cent copper, and was, therefore, of no value. On being assayed further, it showed a value of $40 per ton in gold and $20 in silver. It was shipped to Swansea, and gave a small margin of profit.

"Small quantities of copper ore were shipped to San Francisco from Colusa County during the period from 1862 to 1864. Some of the ore mined from near the surface was very rich in copper, but the grade deteriorated very rapidly with depth.

"It was well known in these early days that copper deposits existed in San Bernardino County and other southern counties, but their distance from shipping points rendered them valueless at that time.

"During all this period the product of our copper mines had to be transported first to San Francisco and thence shipped to Boston, Baltimore, or Swansea. From 1862 to 1865 the price of copper ranged from $4 to $5 per unit; that is, an ore containing 20 per cent copper was worth from $80 to $100 per ton of 2376½ pounds, delivered at any of these three points. Nothing was paid for any gold in the ore below one ounce per ton, and from the silver contents a deduction was made of three-fourths of an ounce for each one per cent of copper. After commencing to fall, the price of copper soon reached a point as low as $3.20 per unit. It was this, coupled with the natural lowering of grade as depth was attained, which sank the copper industry of California into the profound slumber from which it is only just awakening.

"The following *pro forma* statement of a shipment to Swansea may prove interesting at this time. The copper ton there is 21 hundred-

weight, or 2352 pounds, to which must be added, on foreign ores, 3½ pounds draftage per 3 hundredweight, or 24½ pounds per ton, making the ton, as reckoned, 2376½ pounds.

Assay	21.30 per cent copper.	
Less	1.30	
Net	20.00 per cent.	
100 tons (of 2376½ lbs.), at $5 per unit		$10,000 00
Freight from mine to Stockton, at $8 per ton of 2000 lbs.	$950 40	
Freight from Stockton to San Francisco, at $1.25	142 76	
Sampling and assaying, San Francisco, at $1.50	178 20	
Commissions, San Francisco, 2½ per cent	250 00	
Freight from San Francisco to Swansea, at $20 per 2240 lbs.	2,120 00	
Insurance, 3 per cent	300 00	
Expenses at Swansea:		
Sampling, $1.50 per 2240 lbs.	178 20	
Attending sale and guarantee, 3 per cent	300 00	
Harbor and town dues	26 70	
Stamps, stationery, etc.	10 00	
		4,456 26
Net value		$5,543 74

"To smelt copper ore at the mine was, in these early days, simply out of the question. The first smelting works in California consisted of a small reverberatory furnace, erected under the direction of the writer at Antioch, in Contra Costa County, in the year 1863. The fuel was coal from the Mount Diablo mines, for which $8 per ton was paid, and although lignite is not a very good fuel for reverberatory furnaces, with a step grate fairly good results were obtained, and no difficulty was experienced in producing a matte carrying from 45 to 48 per cent copper. Roasting was almost entirely dispensed with, as there was an abundant supply of low-grade oxidized ores to mix with the sulphides. These works were of a purely experimental capacity, not over ten tons per day, and although several thousand tons were smelted, the subsequent fall in the price of copper gave no encouragement to an increase in their capacity, and they finally ceased operations. At the Union copper mine, Copperopolis, a small blast furnace was erected under the direction of Constantine Heusch, and this produced considerable quantities of a very high-grade matte. At the Campo Seco mine, Calaveras County, several thousand tons of ore were treated by kernel roasting, and with some success. A reverberatory furnace was erected on the Cosumnes River, and produced considerable matte of fairly good quality."

This period of activity practically closed in 1868 with a fall in the price of copper, increased cost of mining and lessened values as depth was attained, and the persistent failure of most properties to pay dividends. The report of J. Ross Browne for

1867 was made near the end of this productive era, and the statement there given of the shipments of copper ore and regulus (matte) is approximately complete for that decade. The following table is taken from that report:

Copper Exports from San Francisco, 1862-1867.

[Tons of 2376 pounds.]

Year.	To New York.		To Boston.		To England.		Total.	
	Ores.	Regulus	Ores.	Regulus.	Ores.	Regulus.	Ores.	Regulus.
1862	86	.....	3,574 16/20	.....	.....	.....	3,660 16/20	.....
1863	1,337	.....	4,208 15/16	.....	7 15/20	.....	5,553 10/20	.....
1864	4,905 16/20	.....	5,064	.....	264 7/20	.....	10,234 3/20	.....
1865	4,146 3/20	25	9,050	.....	2,591 16/20	.....	17,787 18/20	25
1866	9,962 3/20	422	4,536 13/20	.....	12,384 13/20	80 10/20	26,883 18/20	502 10/20
1867	2,633	178	.....	.....	1,378	141 18/20	4,511	319 18/20
Totals	23,070 7/20	625	26,434 4/20	.....	17,126 13/20	222 3/20	68,631 4/20	847 3/20

The report of J. Ross Browne on the Mineral Resources of the United States west of the Rocky Mountains for 1868 gives the following statement of the noteworthy smelting plants for the reduction of copper ores which had been erected in California:

Location.	County.	Style of Furnace.	Estimated Cost.
Antioch	Contra Costa	Welsh	$25,000
Copperopolis	Calaveras	German	75,000
Genesee Valley	Plumas	Local	30,000
James Ranch	Mariposa	Haskell's	20,000
Bear Valley	Mariposa	Haskell's	20,000
Hunter Valley	Mariposa	Haskell's	20,000
Near Placerville	Placer	Haskell's	10,000
Near Ashton	Colusa	Haskell's	6,000
Campo Seco	Calaveras	Welsh	30,000
Total			$236,000

There were at the same time two in Oregon, one in Nevada, and one in Arizona. The following comment is made: "Several concentrating and roasting works have also been erected near some of the copper mines at considerable expense. The concentrating works at the Keystone mine at Copperopolis cost $50,000. It is quite fair to calculate that $500,000 has been expended in the construction of smelting and concentrating

works on this coast during the past four years, nearly all of which has proved a loss for the reasons stated."

There are wide discrepancies among the currently recorded estimates of copper production for this and the succeeding decade, and, in fact, for the entire time up to 1894, when the State Mining Bureau began the compilation of annual mineral statistics. It has been found impossible to present any record of California's total copper production worthy to be dignified as statistics, but such figures as are here presented serve to give a general comprehension of the productive course of the industry. Of such value only is the following statement of copper exports from San Francisco, compiled by a San Francisco paper in 1875:

	Tons.	Value.
1861	1,759	$122,581
1862	3,389	293,194
1863	5,933	512,925
1864	14,315	1,994,660
1865	25,830	1,821,360
1866	19,813	1,383,852
1867	7,833	421,546
1868	5,077	227,925
1869	2,542	117,133
1870	2,254	113,732
1871	2,552	121,950
1872	2,193	115,970
1873	1,832	114,852
1874	1,352	67,400
Total	96,674	$7,439,080

The above statement does not inform us what ton was used as a basis of calculation for a period when the short, long, and Welsh tons were variously so used, and it does not distinguish between copper ores and copper matte. It, however, corresponds in a general way with the annual condition of the industry. When transcontinental railroads were established copper shipments began to be also made by rail, and the statistics of exports by sea became still less a reliable measure of production. From the beginning shipments by sea from San Francisco also included ores and some matte from adjoining States and Territories, including British Columbia, Oregon, Nevada, and Arizona, but the bulk of the shipments was from California mines. During the decades of the seventies and

eighties the copper industry was practically at a standstill in this State, and the production of cement copper by the leaching of old dumps provided most of the output, the product in the main going East for the manufacture of mineral paint.

SHASTA COUNTY.

The history of the copper industry in Shasta County is part of the history of the base-ore belt now known as the copper belt; but that history for the period previous to 1895 is the history of attempts to mine the base surface ores for their precious metal values, and copper cuts but a very small incidental figure in the story.

The occurrence of rich copper ores in this mineral belt of Shasta County was noted early in the decade of the fifties, the discovery of copper being in fact practically contemporaneous with that of gold and silver, and copper ores were frequently noted through the succeeding years, but they caused no effort at their exploitation as such. Such ores were encountered in small quantities in tunnels which were opened in the search for gold and silver in the base-ore deposits of the middle and eastern parts of the belt, and a few tons, quite rich in copper and the precious metals, were shipped at different times to San Francisco, but no deposits were ever opened or regarded as valuable chiefly for their copper. For over a generation there was not only no recognition of copper as the element of main importance in this mining district, but there was no general recognition of the metal as one of the important mineral resources of the county. In 1893, but two years before the beginning of the career of the Mountain Copper Company, copper was not even mentioned in a review of the mineral resources of Shasta County in a local paper. The discovery that great bodies of sulphide copper ores lay buried below the gossan cappings of the belt followed the first thorough prospecting of the Iron Mountain property, which begins the real history of the copper industry in this district. The past history of the belt itself is one of gold and silver mining and of nearly forty years of failure thereat, but the importance which copper has suddenly assumed makes this related history pertinent and of interest.

The surface placers of Shasta County were still rich, and its placer mining camps were prosperous when prospectors first noted both gold and copper in the vein formations of the belt. Some of these placer districts closely flanked the copper belt, and had gained the gold in their gravels partly from the ores in the belt itself and partly from the gold quartz veins adjacent to the belt. There appear to have been no attempts at mining the ores of the belt until in the decade of the sixties. As early

SURFACE MINING PLANT OF THE MOUNTAIN COPPER COMPANY, IN SLICK ROCK CANYON, WITH IRON MOUNTAIN AT THE RIGHT.

as 1853 placer gold was discovered in the region of Bully Hill, which became known as the Pittsburg district, by a man named Watson, with whom were associated Riggs, Hughes, and Silverthorn. With this discovery began a stampede which resulted in the location of a large number of placer claims, most of which were of little value. Although some small placers are still worked in this district, active interest had lapsed long before 1870.

In 1862 gold was discovered in the surface rock of the Excelsior claim, near the present site of Copper City, by Jack

Killinger and J. P. Williams. The ore was found to contain silver as well as gold, and another rush into this district was begun for the location of the supposed rich veins of gold and silver. The hills were covered by locations for many miles. It was in the spring of 1862 that the ground now covered by the Bully Hill and adjoining claims was first located by

BLISTER COPPER FROM THE BULLY HILL SMELTER AWAITING SHIPMENT.

Alexander Sanford, and the story of the Bully Hill mining property was begun. The Killinger and Williams company, which was incorporated, sold stock and began the operation of their mine, which was continued until 1865. A shipment of ore was made to Swansea, and realized a fair profit; but as later shipments were less fortunate, they were not long continued. At the same time was organized the Baxter Mining

TUNNEL ENTRANCE AT THE SUGAR LOAF COPPER MINE, SHASTA COUNTY.

Company, which operated on adjoining ground. Meanwhile, at Bully Hill, O. R. Johnson & Co. had acquired some of the claims located by Sanford and begun operations under the corporate name of the Bully Hill Gold, Silver and Copper Mining Company. No attempt at reduction was made, but exploitation was begun on the east face of the hill at the site of what is still tunnel No. 1 of the Bully Hill mine. The work was not successful, and the claims were eventually abandoned. In this period, in the early and middle sixties, Copper City, which was the result of the discoveries and the mining life of this district, enjoyed a lively boom and looked forward to a long and great career. These mining enterprises, dealing with very base surface ores at an early stage in the development of lode mining in the State, and at a long distance from ore markets, soon demonstrated the impossibility of realizing profits, the bottom dropped out of the mining boom, and little was done for another decade.

It was early in the decade of the sixties that Iron Mountain began to cut any figure in the story. William Magee, a United States land surveyor, noted the enormous capping of gossan on the mountain, and in association with Charles Camden secured the property as an iron mine. It was idly held as a simple iron deposit of possible future value until 1879.

The decade of the seventies brought a revival of interest and activity to the Pittsburg district. The claims in Bully Hill, which had been abandoned by the Bully Hill Company, had been relocated by T. M. and J. W. Popejoy, who sold them to Alvin Potter & Co. in 1877. Potter reopened and retimbered the old tunnel (No. 1), and at the same time carried on other developments. Soon the property passed to the Extra Mining Company, which built the first mill at Copper City in 1877. A tramway was built at an enormous expense to convey ores from Bully Hill by gravity to the mill. During the few years (perhaps three or four) in which the company operated, it was said to have extracted as much as $640,000 from these ores, and interest on borrowed money, a part of the principal, and dividends were rapidly paid, but the property was finally turned over to creditors. The Extra Mining Company worked only the surface ores from these mines, having no successful process for the reduction of the baser ores, though an attempt

was made at roasting. The mill was run for some years for the creditors, though not very successfully. Later Messrs. Potter and Hall obtained possession of the mill and tramway, purchased the Jenny June claim from H. C. McClure, and successfully worked these ores for a time, but the base ores finally caused them to abandon the work.

Iron Mountain makes its entry as a factor in the industrial story of the belt in 1879. In that year James Sallee, whose name was thenceforth to be prominently associated with the development of the copper belt, visited Shasta County and incidentally Iron Mountain. His assays of surface ores revealed the presence of silver and gold, and the outcome of his discovery was the acquirement of a one-third interest in the property by himself and Alvin Potter, under whose direction the mine began the second period of its evolution.

This discovery was soon noised abroad and a characteristic stampede to the region ensued. The popular effect is well shown in a news letter to the Mining and Scientific Press from a Whiskeytown correspondent in June, 1880. He writes in part: "At this particular time, in this part of Shasta County, the silver boom is up high, and such expressions as 'the most extensive and the richest silver ledge the world has ever seen' are frequent. Some five or six miles from the ancient town of Shasta was known to exist what was called Iron Mountain. Nothing was expected of it, and no one prospected there. A curious expert came from the city and has been secretly looking at its formations, assays have been made of his finds, and now the whole country is wild and claims are staked off for miles. A new silver belt has been discovered, the assays of which go away up into the hundreds."

Sallee found his gold and silver values in the gossan crusts of the surface, and this material constituted the ore that was subsequently worked. Under the direction of Sallee and Potter ore was transported by pack train and wagon to Redding, and from this point was shipped by rail to reduction works in Denver, Colorado. The ore was of sufficient value, however, in spite of this laborious method of handling, to provide the means of constructing a wagon road from the mines to the railroad at Middle Creek, a distance of eight or more miles. With the completion of this wagon road the handling of the ores was to

some extent simplified and the expense of its reduction was correspondingly lessened. The exact results of this method of work are not known, although it was kept up for some years, evidently with some profit.

In 1884, John O. Earl and Charles Ellsworth, representing a Honolulu company, bonded the property with the intent of buying it, and proceeded with the negotiations to the point of making a payment of $30,000 and completing its equipment with an elaborate plant. The equipment of the mine included a 20-stamp mill, 125-horsepower engine, boilers, pans, and settlers, and in addition a small sawmill. Before any production was effected, however, the entire plant and mine were returned to the original owners for a consideration of $10,000. James Sallee, as part owner and superintendent of the newly equipped mine, undertook its operation and worked it successfully until it was sold to the present owners, to whom it appeared as an immense deposit of valuable copper ore.

The first recognition of the possibilities of this mine as an available copper deposit was by Hugh McDonald, who called it to the attention of Judge N. F. Cleary. The bond obtained by McDonald was transferred to Cleary, who, through the influence of Alexander Hill of the Rio Tinto mine, was successful in effecting its sale to the Rothschild and Fielding people of London and New York. These factions combined in its purchase, paying for the property the sum of $300,000, and establishing a working capital of $200,000. This deal was consummated in the early part of 1895. The new company incorporated as the Mountain Mining Company, and began at once the development of their deposits, the building of a railroad, and the erection of a suitable reduction plant. In September, 1895, a formal transfer of the Fielding interests was made to the Mountain Mining Company, Ltd., which continued its operations under the management of Mr. Hill. In January, 1897, the property was transferred to the Mountain Copper Company of London.

The history of the Peck and Afterthought mines in the Cow Creek district has been in many respects parallel to that of the Iron Mountain and the Bully Hill. The earliest attempts at operation were made for the extraction of gold and silver values from the oxidized surface ores. Later an effort was made to

work the baser ores by a process of roasting and milling. C. M. Peck, who had erected the first ore mill in the vicinity of Copper City, also put up the first furnace for smelting in Shasta County. Having obtained for a nominal sum the property afterward incorporated and known as the Peck mine, and now included in the Afterthought mine, he began its successful operation upon the oxidized surface ores. In 1875 he erected a small reverberatory furnace, in which wood was to be used as a fuel in the reduction of the baser ores. Naturally this attempt was not successful, as these ores have since defied more rigorous methods. Upon the advice of a Mr. Williams, a second furnace, of the water-jacket pattern, was built, in which charcoal was to be used. The refractory character of the ore, which occasioned repeated freezing and other difficulties which could not then be surmounted, proved to be too much, and this attempt also ended in failure. It was claimed, however, that a continuous and fairly successful run of seven days was made at one time. The quantity of charcoal required amounted to nearly 1000 bushels per day. Subsequently, John Williams, father of the former superintendent, and afterward a man named Gerrish, made other unsuccessful attempts to reduce the ore in the same furnace.

Later on this property was acquired by Joseph Cone and others of Red Bluff, who erected a small water-jacket furnace of 25 tons capacity. Two attempts were made with this furnace, both of which terminated without success. During the period in which Peck operated in this district, he had discovered the Donkey mine, which he sold to A. J. Cook for the sum of $1100. The ores of this mine are similar to those of the Afterthought.

SHASTA COUNTY.

Shasta County commands first and chief attention in a survey of the present condition of California's rising copper industry. In its great copper or "base-ore" belt, which curves as a thirty-mile string of ore deposits through its west central part, are the mines and smelting plants which yield most of the current copper output of the State, and the various extensive ore bodies whose exploitation gives the chief promise of an early and marked increase of copper production. While the copper industry is directly confined in Shasta County to one definite mineral belt, the county as a whole presents various features contributing to the exceptionally favorable conditions surrounding the industry.

The county lies in the mountainous region about the head of the Sacramento Valley, nearly equally distant from the western, northern, and eastern boundaries of the State, and is about 90 miles in length and 60 miles in width, having an area of 3675 square miles. The western border of the county is along the Trinity range summit, and the county reaches eastward high up the slope of the Sierra Nevada range, which bears westward and merges with the Coast Range in Shasta and Siskiyou counties. Short, irregular ranges fill the greater part of the county between the main ranges to the east and west. The Sacramento Valley thrusts its rapidly narrowing northern end a short distance up into the southwestern part, affording the principal agricultural and horticultural region of the county and meeting the long canyon of the Sacramento River a little above Redding, about 20 miles above the southern boundary.

In the southeastern corner of the county is Lassen Peak, an extinct volcano, the lavas from which have blanketed the eastern portion of the county as far as the Sacramento River. From the valley and lower foothills of the southern part of

the county the surface increases in ruggedness and elevation northward, as well as eastward and westward, until altitudes of 5000 to 6000 feet are reached. The copper belt occupies a position between these extremes, the altitudes of mountain summits and canyon floors along the belt generally ranging between 1000 and 3600 feet.

Nature has given this county a splendid water supply. The rainfall, occurring chiefly in the winter, exceeds forty inches as a rule, and the snows of the higher ranges maintain the streams throughout the summer months. The principal streams are the Sacramento, McCloud, and Pitt rivers, the first two rising in the mountains above the northern boundary, and the last in Modoc County. The Sacramento flows southward through the western half of the county in a deep, sinuous, and exceedingly picturesque canyon, crossing the copper belt a little above the apex of the Sacramento Valley plain. The torrential Pitt crosses the axis of the Sierra range through heavy forests and deep canyons to join the Sacramento in the midst of the copper belt. The no less picturesque McCloud discharges into the Pitt amid the gossan cappings of the copper deposits. Tributary creeks, prominently identified with the copper belt, also cross it on both sides of the Sacramento, and are valuable sources of water supplies. There is thus a general convergence of the important rivers and creeks of the county in and through the chief mineral region.

The streams afford exceptionally valuable power resources. Their fall is rapid, their volume reliable, and the opportunities for the utilization of their waters for generating electric power are many. The Pitt presents many falls and cascades, and Fall River flows over a precipice sixty feet high just before joining the Pitt, high in the mountains. Important electric transmission plants are now in operation.

The county has almost inexhaustible supplies of timber in heavy forests of yellow and sugar pine and fir, clustered in the higher ranges about the upper courses of the chief rivers, those along the Pitt being especially available. Most of the timber and wood now used in large quantities by the principal mining companies is floated down from these sources. Elsewhere through the county, and adjacent to the mining districts,

generally, the timber supplies are scant or inferior, as a rule, though on the higher ridges, and on the more moist northern slopes of others, the yellow pine is here and there found in satisfactory abundance, and is extensively utilized. In the foothill zone the forest growths comprise mainly black, white, and live oaks and "digger pine," and there are widespread growths of underbrush (chaparral), along with scrub oaks and small pines.

The California and Oregon line of the Southern Pacific railway system crosses the county and the copper belt along the course of the Sacramento River, and this important mining field thus has the advantage of close proximity to a main commercial highway. Several efforts have been made to accomplish the construction of a railroad westward from Redding through Trinity and Humboldt counties to Eureka on the Pacific coast, to open up a splendid mining region in the Coast ranges.

While the copper belt, with which this Bulletin is chiefly concerned, is now by far the leading feature of Shasta County's mineral resources, those resources are varied and quite widely distributed elsewhere. The eastern half of the county being generally buried under lava deposits which effectually hide the minerals that undoubtedly exist, the mining industry is confined to the western portion. The crescent-shape copper belt presents its eastern end a little south of the center of the county, the belt, as indicated by exposures, being prolonged eastward into the lava sheet; but with this exception, the county's mining industry is confined to the western third of the county, and mainly to the portion west of the Sacramento River.

There were rich early placers in this region, and extensive recent and ancient auriferous gravel deposits remain, affording opportunities for various forms of placer mining, including gold dredging. Quartz mining was of slow development, owing to the base character of the ores in most of the districts in which gold-bearing veins were early discovered. Several quartz mining districts have been more or less successfully exploited, the most noted one being the French Gulch district at the western side of the county, in which the important Niagara and Glad-

stone mines, yielding free-milling ores, were developed many years ago. Other quartz mining districts are distributed along the western side of the county for sixty miles. The ores of these districts are free-milling in some places, but are usually base, and they are variously characterized by the presence of gold, gold and silver, and gold, silver and copper, in association with baser metals. To these districts mining enterprise is newly turning, giving promise of important new discoveries and developments.

The recent exploitation of the copper mines has placed Shasta far in the lead of the mineral-producing counties of the State. Its total mineral output in 1906 was $5,745,843. Of this output, $4,338,121 was in copper. The gold and silver carried by the copper ores smelted and the silicious ores used as fluxes, together with the output of placer and quartz mines in districts outside the copper belt, afforded $1,253,627 in the precious metals, of which $819,144 was in gold and $434,483 (coinage value) in silver. This made Shasta also the leading silver-producing county of the State. In 1896, just before copper production began, the total mineral output was but $813,593. The mineral statistics for 1907 show that 27,844,364 pounds of copper were produced, valued at $5,568,873, further increasing Shasta's mineral preëminence. Shasta's total production of all minerals in 1907 was $7,084,706, of which $791,997 was in gold and $370,211 in silver. Various mineral products are minor features of the record.

The following table, giving the annual values of the three chief mineral products and the total annual mineral production from 1894 to 1907, inclusive, shows the expansion due to the recent development of the copper industry. Besides the value of gold, silver, and copper, the totals include the minor mineral products, embracing $1500 in iron in 1894, chrome in 1895 and 1900, and mineral waters, lime, limestone, and brick in most of the years. The gold increase is comparatively small, owing to the closing of several important gold mines at about the period that the Mountain Copper Company began producing gold as a by-product. The large increase in silver in 1900 was partly due to its being measured in coinage value for that year instead of in commercial value as in preceding years:

Year.	Gold.	Silver.	Copper.	All Minerals.
1894	$617,436	$5,032		$715,769
1895	781,696	28,417		811,233
1896	599,209	24,233	$184,208	813,593
1897	569,071	96,869	1,535,966	2,224,700
1898	860,180	171,868	2,465,830	3,510,728
1899	873,719	196,213	3,565,023	4,661,980
1900	733,467	635,640	4,166,735	5,574,026
1901	927,975	891,994	4,881,048	6,737,571
1902	878,706	306,887	2,496,731	3,730,049
1903	771,242	203,991	2,171,497	3,201,680
1904	1,031,429	399,660	3,439,974	4,898,033
1905	684,952	167,548	1,688,614	2,579,014
1906	819,144	434,483	4,338,121	5,745,843
1907	791,997	370,211	5,568,873	7,084,706
Totals	$10,940,223	$3,933,046	$36,502,620	$51,441,705

As these figures indicate, copper is the chief product and the chief basis of the mining prosperity and prospects of the county. All of the silver is produced by the smelters from ores mined chiefly for their copper; and in the temporary absence of production in some important mines, the gold output has, until recently, been sustained in the same way.

At the present time several prominent independent gold-producers are being operated, and the output, exclusive of gold produced by ores mined chiefly for copper, is as great as it has been at any time during the past ten or fifteen years.

THE COPPER BELT.

Shasta County's copper belt is composed of a series of ore deposits arranged in the form of a crescent, which bends through the low mountains and foothills directly north of the head of the Sacramento Valley, and which spans a distance of about twenty-five miles between the eastern and western horns. The apex of the Sacramento Valley plain and the city of Redding are near its western end and but a little south of the chord of the arc described by the belt. Iron Mountain, at the end of the western horn, is about ten miles northwest of Redding, in a direct line, and the eastern horn, in the Furnaceville district, is about twenty miles north of east from the same point. The length of the belt is approximately thirty miles, and the width from one half to four miles.

The term "belt" is used with the broad meaning which it

properly carries, and not as synonymous with "lode." The ore deposits do not mark a practically continuous fissure system in which directly related vein formations have resulted, but occur as disconnected masses, or groups of vein formations, forming individual lodes and districts. These groups of deposits vary in form of occurrence from massive, flat-lying, lenticular beds of sulphides on the west, to irregular vein formations in the eastern half of the belt, and they also vary in their mineralization; but they are successively ranged, with considerable regularity, along the curved line described, forming a belt three or four miles wide in places. In several ways this series of deposits presents features of unity and individuality, which enforce its conception as one definite mineral belt, and which set it apart from other ore deposits in that part of the State.

The belt is throughout superficially marked by massive exposures of the gossan which nearly everywhere caps its mineralized formations. Upon the elevations between the canyons cut by the streams, these dark croppings of the iron oxides resulting from the decomposition of surface sulphide ores stand out in places with striking boldness. A cursory survey of the belt as a whole shows these ferruginous surface formations to be practically continuous throughout, but in an irregular and disjointed way, and coursing in varying directions. Especially striking is the great gossan cap of Iron Mountain, with which the belt worthily begins, or ends. The ridge forming this mountain rises nearly a thousand feet above Slick Rock and Boulder creeks on either side, over a mile apart, and at the top the gossan formation, 300 feet wide, displays nearly perpendicular walls that rise high above the top of the slope into which the tunnels of the Mountain Copper Company open. Southerly from Iron Mountain but two or three known copper deposits, widely separated, occur, the mineral formations of the belt being succeeded through the adjacent regions by gold quartz veins.

For ten miles northeasterly from Iron Mountain and nearly to the Sacramento River, the belt is outlined by a quite continuous succession of both gossan outcrops and important groups of copper claims, in many of which exploration is steadily proceeding. For the distance named, the belt, as

indicated by the distribution of copper mining claims, exhibits a width of approximately three miles. Between Boulder Creek, at the northern side of Iron Mountain, and the Sacramento River, the belt is cut through by three deep creek canyons.

The belt intersects the Sacramento River at about the point where it receives the Pitt, and for nearly ten miles eastward it exhibits its gossan croppings on both sides of the latter stream, but mainly on the northern side. About four miles east of the Sacramento the Pitt is joined by the McCloud River, which thus ends in the midst of the copper belt. Farther eastward the belt is entered by the Pitt where it turns on its final westward course, and it is crossed by streams tributary to the Pitt and Sacramento. Through the whole course of the belt a multitude of gulches help give a very rugged character to the region. These gashes made by the waters in the "iron hat" of the belt further diminish its apparent continuity, the gossans having here and there been eroded away or covered by surface wash, and being found principally on the elevations.

The geology and mineralogy of the belt are specially treated of in the succeeding section. The ore deposits are composed mainly of sulphides occurring in eruptive formations. West of the Sacramento the deposits are in the form of irregular lenses in flat or inclined positions. They have been shown, in some cases, to be several hundred feet in length and breadth, with thicknesses of 50 to 300 feet, displaying contents amounting in the Iron Mountain and Balaklala mines to quantities exceeding a million tons, and indicating similarly large proportions in other properties of smaller development. In the central and eastern portions of the belt the ores occur in vein formations.

The ores all carry gold and silver. West of the Sacramento River the percentages of the precious metals are small, though constituting an important element of the ore values. The Iron Mountain ores are stated to yield about $1 in gold and two ounces of silver per ton, and these quantities are probably characteristic of the ores of the other deposits of that part of the belt. These ores carry very low percentages of the baser metals, as zinc, antimony, arsenic, etc. In the central and eastern districts of the belt the gold and silver, as well as the copper values, are frequently much higher than in any large

ore bodies developed to the west, and they carry the baser elements in much greater quantity and variety. Throughout the belt, the most important copper properties have in past years been worked for the gold and silver values remaining in the decomposed portions of the deposits near the surface and above the copper sulphides to which attention is now directed.

Adjacent to different parts of the belt are gold quartz districts, in which are many veins carrying low, medium, or high grade ores, which are base, as a rule, and can not be efficiently and profitably reduced by milling processes. The western horn of the belt is practically surrounded by such veins. They occur notably in the region of the old town of Shasta, four miles south of Iron Mountain, and are distributed for several miles south and east of this end of the belt through the Shasta and Flat Creek districts, the latter lying between the belt and the Sacramento River. Eastward from this portion of the belt, across the Sacramento River and within and without the chord of the belt's arc, is the Old Diggings district, presenting groups of quartz claims extending over several miles. Some important quartz mines have been developed in these districts, including the Mount Shasta in the Shasta district, and the Texas Consolidated in the latter. Other quartz districts similarly attend the belt at other points along its course, and gold quartz veins are abundant in close proximity to the belt generally. These silicious ores thus provide abundant and convenient fluxing materials for use in smelting the sulphide copper ores. In turn, the smelters have created a market for these ores and enabled the development and mining of a number of quartz properties. The stimulus thus afforded quartz mining in this region is one of the important local benefits of the development of the copper industry. Gold ores are not only supplied from closely adjacent districts, but are hauled by teams and shipped by rail from quite remote localities, including points in Siskiyou and Trinity counties, the ores being rich enough to stand the large transportation costs.

Other fluxing materials are equally plentiful and convenient. Iron ores and limestone are also used for fluxing. Limestones are the most abundant, and are found along large belts near the smelters. The supply is practically inexhaustible. Iron ores, both magnetite and limonite, have been used for some of

the more refractory sulphides, but the former has not been found to be suitable for such uses. It is now believed that a mixture of ores from this belt can be made that will obviate the use of iron ores.

The copper belt thus presents many favorable conditions for copper mining and smelting. There are distributed through a long mineral belt massive ore deposits whose quantities, as well as values, are attractive to conservative mining capital. These deposits are usually embedded in great hills, and can be economically explored and mined through tunnels. Water is especially abundant, and desirable sites for reduction works are conveniently available. Opportunities for the generation of electric power are widely present. The belt is bisected by a main railroad line, and highways reach the various districts. Climatic conditions are all favorable. The wood and timber supply is ample. At the Keswick smelters wood now costs about $4.25 per cord. Alabama coke, carrying 16 per cent ash, can be delivered at Redding for about $13 per ton. Belgian coke, with 15 per cent ash, has been obtained for $12.20 per ton.

From 1895, when the Iron Mountain mine was recognized as a copper mine and passed into the possession of the Mountain Mining Company, until a few years ago, this property at the western end of the copper belt, and the Bully Hill mine at the eastern end, were the two principal producers. Up to January 1, 1902, the Iron Mountain mine had produced 825,000 tons of ore, which were carried on the narrow gauge railway eleven miles to the company's smelting plant at Keswick for treatment. The resulting matte and blister copper were shipped to the company's refinery in New Jersey and yielded 120,000,000 pounds of fine copper. The company had paid in dividends up to December 31, 1900, over 50 per cent of the capital stock of $6,250,000. The Bully Hill mine is credited with having reduced 50,000 tons of ore averaging 10 per cent copper, affording 5,000 tons, or 11,200,000 pounds of copper, with an equal value of precious metals, during the first ten months after beginning operations in May, 1900. This is an unofficial estimate, but is believed to be approximately correct.

Groups of claims are closely ranged for ten miles northeast of Iron Mountain, embracing broken and wooded canyons,

VIEW OF THE BULLY HILL COPPER MINES FROM THE NORTH.

hillsides and elevations, and covering widths of three miles in places. Several of these properties have developed within the last three or four years into paying mines, equalling or surpassing in importance the Bully Hill mine. These are: the Balaklala, which has recently completed a large smelter, and the Mammoth, whose smelter has been running for several years, and has lately been considerably enlarged. The mines of the Trinity Copper Company, headed by Thomas W. Lawson, of Boston, the chief property of which, the Shasta

BULLY HILL, SHASTA COUNTY, SHOWING ORIGINAL TUNNEL OPENED IN 1863.

King, adjoins the Balaklala, about four miles east of Iron Mountain, are being prospected. Of the properties in the eastern portion of the belt, the Afterthought has made the greatest progress, having erected a smelter near the mine. In the Donkey mine near by work has been resumed and many improvements made. In 1902 the number of mines in the Shasta copper belt was given as 57, and the number of feet of tunnels and drifts as 39,000, approximately, aside of the workings of the Mountain Copper mine. A computation of the extent of the underground workings at the present time is not possible, because the data are not obtainable, but it is

safe to say that the number of mines has increased about 50 per cent, and the amount of work has at least doubled.

Shafts cut a noticeably small figure along the copper belt, and they may be practically regarded as non-existent. They have nearly all been early prospect shafts sunk in preliminary surface exploration. Throughout the belt development and mining are conducted through tunnels, which the topography so generally favors.

The range of the altitudes credited to the mines is wide, and illustrates the rugged nature of the country. The highest properties are in the elevations west of the Sacramento River. The top of Iron Mountain is 3000 feet above the sea and 2400 feet above the Sacramento River. The Marshall and Waters group, two miles north of Iron Mountain, includes a point 3500 feet in altitude, and the Summit group, farther north, lies at 3000 feet. The lowest property is the Hotchkiss, 750 feet, a little south of Bully Hill, which rises to 1400 feet. Forty-four properties are above 1000 feet, twenty above 2000 feet, and fourteen are at altitudes below 1000 feet. Redding, on the Sacramento River, is 550 feet above the sea.

The development of water powers and electrical plants, the building of towns and branch railroads, the stimulation of gold mining, lumbering, manufacturing, and other industrial enterprises, and increase of population and of general prosperity are among the features incidental to the progress of the copper industry and mainly consequent on it.

GEOLOGY OF THE COPPER BELT.

It would not be possible to include in this report a discussion of the geological features of the copper belt that would be in any degree complete. Only brief statements can here be given regarding the various classes of rocks more directly connected with the ore deposits.

The oldest sedimentary rocks that are encountered here are those of the Devonian age. They are found especially along the western districts, extending at intervals northward from Clear Creek to the Big Backbone, or beyond. They have been found also to the east of the Sacramento River, in the vicinity of Baird and perhaps farther south. These rocks are mainly

metamorphic, often becoming schistose or crystalline. They include the limestones and their underlying slates, or schists, near Kennet and Copley, and at the lime quarry on Clear Creek in the vicinity of Horsetown. Probably the schists entangled with the eruptives throughout the western districts are of Devonian age.

The next succeeding period represented among the sedimentary rocks is that of the Carboniferous. This period is represented by the conspicuous limestone belt east of the McCloud River, near Baird, and extending in a southerly direction toward the Great Valley to the south of Pitt River. Bass's ranch, on the old Oregon road, is a classical locality for Carboniferous fossils in California. The Carboniferous beds, like the Devonian, include both limestones and slates, both of which are in a large degree metamorphic. The thick limestones are underlain by dark slates, and both are very fossiliferous. These beds will be referred to again in connection with certain metalliferous deposits in the vicinity of Pitt River.

Succeeding the Carboniferous period, the next oldest sedimentary rocks in this region are those of the Triassic age. These occur still farther east in the vicinity of Squaw Creek and Bear Mountain. They consist for the most part of dark, thin-bedded, silicious slates, overlain in some places by limestone, which is usually very fossiliferous. The Triassic strata are much less affected by metamorphism than either the Carboniferous or Devonian rocks. The limestone is highly crystalline, but the slates are rarely if ever schisted, though they are much disturbed in their position, being usually more or less tilted.

The lower portion of the Triassic beds contains thick beds of fragmental volcanic rock of an andesitic character, resembling beds of volcanic tuff of a much younger age. These are especially noticeable near the bridge on Pitt River east of Copper City. It is curious to note the general resemblance of the sediments in these three distinct periods. In each case the lower beds are of a slaty nature, while the upper are of limestone. The limestones to the north and east of Bully Hill belong to the Triassic period, and have furnished not only an abundance of marine shells, but also the bones of extinct saurians.

The last important sedimentary beds that require mention are those of the Cretaceous period. These beds are confined to the lower foothills of the copper belt, and to the valley floor. They occur near Horsetown, Redding, Sand Flat, Dry Creek, and Cow Creek, forming an irregular belt or zone extending in a northeasterly direction toward the low country north of Lassen Peak. They are of Upper Cretaceous age, and are generally fossiliferous. The beds are of shale and sandstone, which have a relatively slight dip to the south or east. It is this series which has been prospected for petroleum.

The Cretaceous beds, and in fact some of the older beds of the foothills, are overlain by beds of volcanic tuff which were once more extensive in their distribution than now, and also by accumulations of alluvial gravels. It is impossible in the limited space of this report to give more than a mere outline of these deposits, but it is important that at least a few paragraphs be selected from the geological history of the region in order that there may be a better comprehension of the paragraphs which follow.

THE IGNEOUS ROCKS.

More vitally connected with the ore deposits of the copper belt are the igneous rocks embraced in its area. Those which are directly concerned are either of one class, or they belong to classes closely related, and are probably of about the same age. The geological age to which they seem referable can not be younger than the Cretaceous nor older than the Triassic. Their approach toward the surface of the earth as intrusions covering an extensive territory was no doubt very gradual, though in its late stages it was doubtless accompanied by eruptions of lavas and the formations of dikes that were of more sudden creation. Most of these rocks are of an acid character, or in other words, high in their percentage of silica. It would be interesting to note the relation of these igneous rocks to the topographic features of the country, to the older sedimentary rocks, and to the ore deposits themselves, but this would carry the discussion beyond the limits of the present paper. A little may be said, however, regarding the structural features of the country and the classification of these rocks.

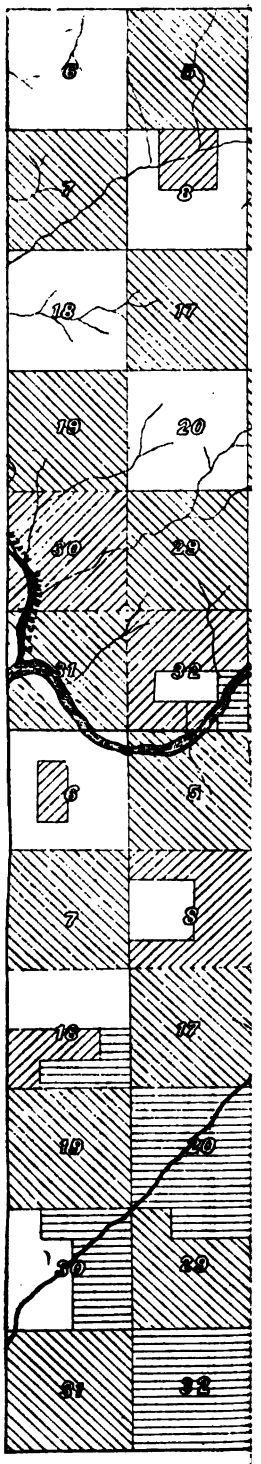
In the main, eruptive or igneous rocks have the appearance of underlying all of the sedimentary rocks, including those of Devonian as well as those of Cretaceous age. In all the larger streams, and in many of the smaller ones, erosion has cut down through the overlying sedimentary rocks and exposed the eruptives along the valley bottoms. As extensive intrusions which have risen into the old sedimentary rocks, there are many variations, and no less variety also in the flows of volcanic rocks that finally resulted. The deep-seated phases of these eruptions include granite, granite porphyry (quartz porphyry), and diorite, including quartz diorite. These rocks are either coarsely or finely crystalline, and of a light gray color, greenish or dark, varying with locality.

Rhyolite, trachyte, and andesite are names properly given to surface flows of volcanic rocks, and such flows occur throughout the copper districts, associated with tuffs and breccias of a similar age and character. These flows doubtless correspond in character to the deep-seated rocks already mentioned, and represent the outpourings that followed their action. These volcanic rocks, including both the flows and the fragmental rocks, are especially seen near Iron Mountain, the Shasta King mine, Bully Hill, and the Afterthought. The term porphyry should perhaps be applied only to dike rocks, and some of these are found along the copper belt. There are certain dikes, however, which cut the limestones in the vicinity of Baird, which should be classed as diabases. These accompany the iron ores and the occurrences of magnetic pyrite.

METAMORPHIC ROCKS.

A third and important class of rocks that are frequent in the copper belt includes most of the crystalline limestone, and certain "slates" and schists near Copley, Redding, and Clear Creek. These rocks are largely of Devonian age, and appear to be partly of an igneous origin. Truly metamorphosed sedimentary rocks are very often involved in the eruptive and volcanic rocks along the copper belt, and are not always easily distinguished from them, where the metamorphic action has been intense and the weathering considerable.

In the main structural features, therefore, the copper belt consists of a number of north and south folds, or belts, of sedi-



MAP OF A PORTION

CALIFORNIA
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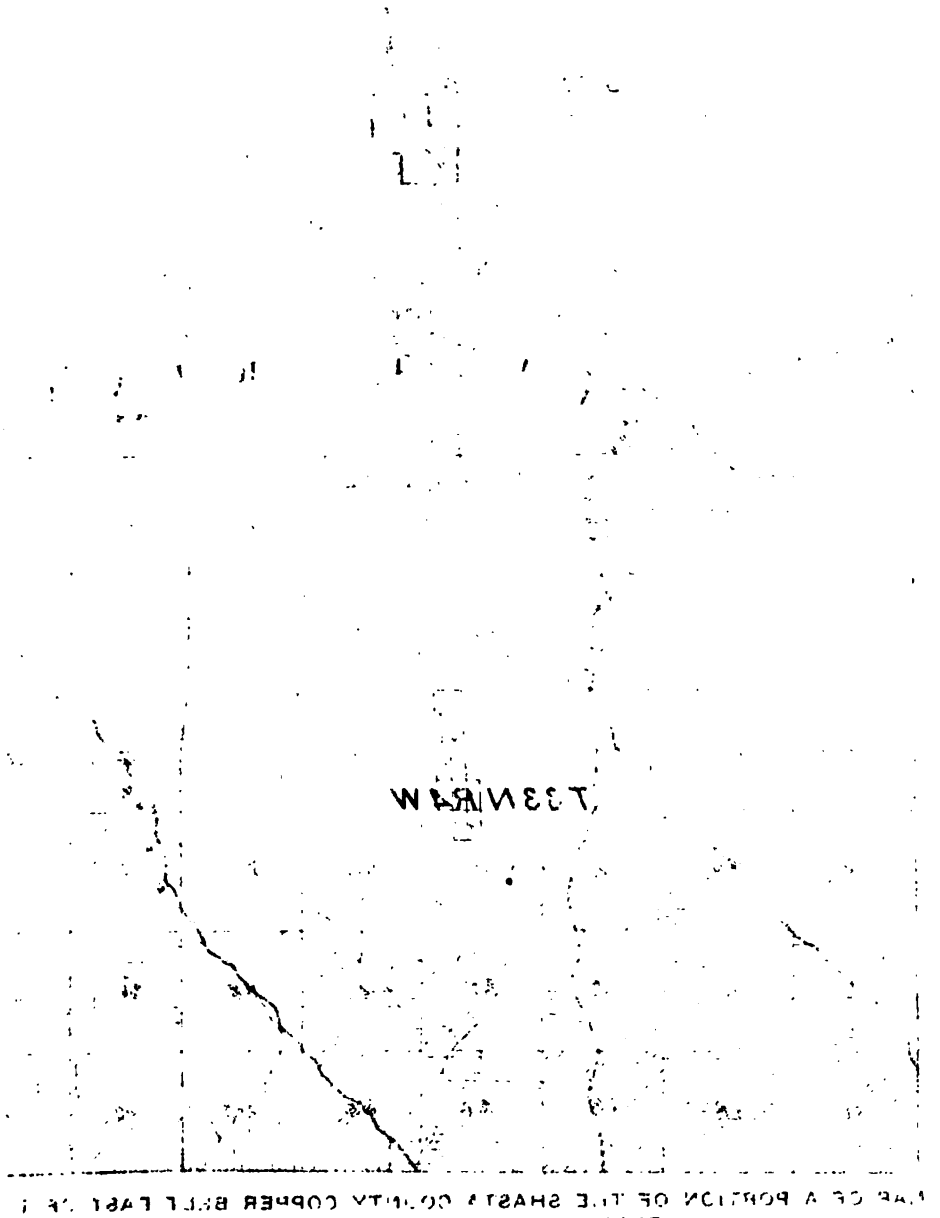

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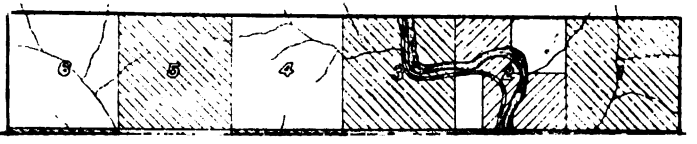
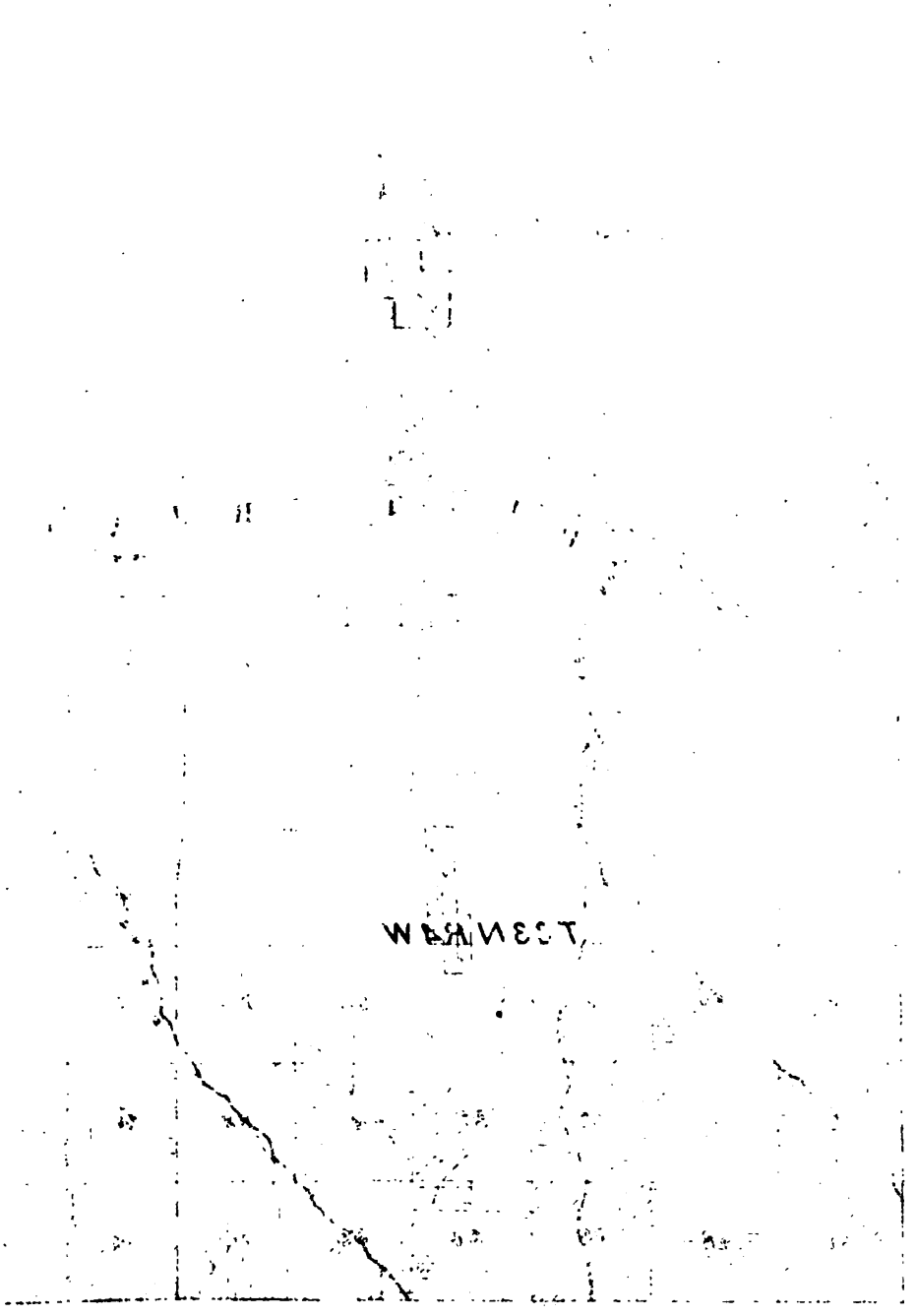
LEWIS E. AUBURY, STATE MINERALOGIST



SULPHIDE COPPER DISTRICT



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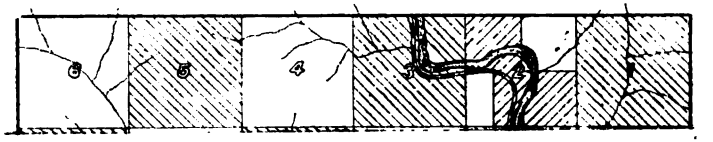
SULPHIDE COPPER DISTRICT



MAP OF A PORTION OF THE SHASTA COUNTY COPPER BELT EAST
BULLY HILL DISTRICT. SHOWING THE PRINCIPAL

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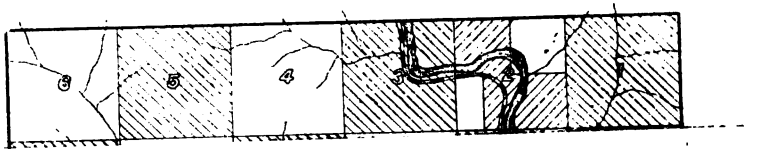
LEWIS E. AUBURY.
STATE MINERALOGIST.

SULPHIDE COPPER DISTRICT.



mentary rocks, which belong to a succession of periods, and beneath which extend the rocks of the great granitic intrusion. Dike rocks have been found penetrating both the eruptives and the overlying sedimentary rocks. A clear knowledge of these structural features in a measure simplifies many things relating to the ore deposits.

ORE DEPOSITS.

The deposits of copper ore belonging to the copper belt, that are now attracting so much attention in this country, are quite unlike the usual quartz veins as ordinarily understood, both as to their forms as ore bodies and as to their origin, though probably they are not different from bodies of copper ore occurring elsewhere. There is considerable misconception in this regard. As a rule these ore bodies are of very great size and consist of large bodies of massive sulphides occurring along the borders of or within areas of eruptive rocks. It is rarely that any considerable bodies of ore have been found in this belt inclosed in unaltered sedimentary rocks, or in fact in metamorphic rocks other than schists. They are not commonly separated from their inclosing rocks by sharply defined boundaries, but fade out by gradual transitions from ore in which there is more or less waste to rock in which there is more or less ore, and finally into rock with only a small percentage of disseminated sulphides. They are not often bounded along the sides by definite walls, though sometimes one wall is in evidence, emphasized as to its extent and importance by a selvage of clay and other similar material which testifies to a certain amount of either lateral or vertical movement. It does not always appear, however, that such walls have had any connection with the genesis of the ore. The ore bodies are not conformable in their extent to the directions of these walls, and it may be that the walls are only planes of shearing developed secondarily.

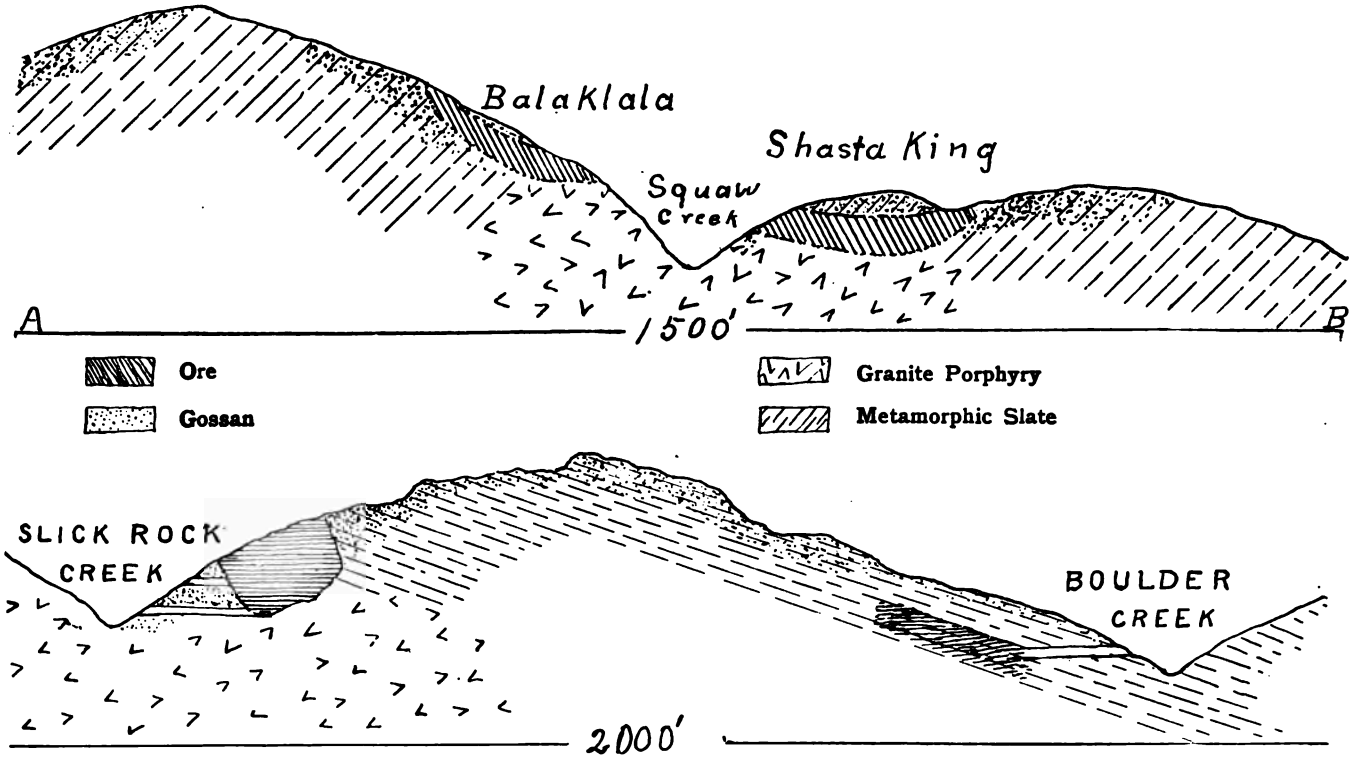
There are three types of ore deposits within the copper belt that require notice in this report, differing not only in their mineralogy and form, but also in their mode of origin, to a certain extent. These are: (1) Deposits of magnetic iron (magnetite), with pyrrhotite and pyrite; (2) Massive deposits of pyrite, chalcopyrite, and other sulphides; (3) Vein-like deposits

of mixed sulphides, including a relatively large percentage of gold, silver, zinc, antimony, etc.

The first class of deposits occurs most abundantly to the north of Pitt River near the mouth of the McCloud. One and a half miles southeast of Baird very large deposits of magnetic iron occur, carrying a small percentage of iron sulphide, with some value in gold. Associated with them are smaller veins of copper ore. The largest deposit of magnetic iron ore at the head of Potter Creek can be easily traced for more than half a mile, and undoubtedly has a width in some places of more than 100 feet. Considerable bodies of this ore are strongly polarized. It is associated with bodies of actinolite and other iron-bearing silicates representing intense local metamorphism. The iron ores are for the most part connected directly with the diorite near its contact with the massive carboniferous limestones, though in some cases the ore is found in narrow dikes inclosed in the limestone itself. These ore bodies are evidently of eruptive origin, and probably represent extremely basic segregations from the eruptive mass.

The deposits of the second class are those of mixed pyrite, chalcopyrite, and other sulphides, which form the principal deposits of copper ore lying west of the Sacramento River. This class includes the ore bodies of Iron Mountain, Squaw Creek, Backbone Creek, etc. They are inclosed either partially or wholly in the metamorphic schists of the western districts, and are usually closely connected with the acid eruptives involved with them. These deposits appear to have been one of the results of metasomatic action attending the intrusion or extrusion of the acid eruptive rocks. Some of the deposits are found closely connected with rhyolitic flows.

The ore deposits of the third class are represented by those of Copper City, the Bully Hill, Afterthought, and other mines. In form they have some resemblances to irregular veins with a succession of ore shoots arranged along certain lines. Although in the manner of their origin and occurrence they are not thought to be different from the preceding, yet they are much more limited in extent, and are characterized by the presence of larger percentages of gold, silver, zinc, and antimony, and sometimes copper, together with barites as a gangue mineral. They have also a correspondingly low percentage of iron.



GEOLOGICAL SECTIONS ACCORDING TO AVAILABLE DATA. THE UPPER ONE SHOWS THE BALAKLALA AND SHASTA KING FORMATIONS; THE LOWER SKETCH IS OF A SECTION OF IRON MOUNTAIN.

The alteration of these ores, especially those of the latter classes, is of special interest. Where surface erosion has exposed or truncated the ore bodies, there has usually been a large amount of oxidation and destruction of the sulphides. The oxidation and the formation of soluble sulphates have resulted in a leaching of certain metallic contents, which have been carried either downward or outward according to the direction of the drainage. Residual accumulations of metallic oxides is the rule, often forming thick crusts of masses of "gossan," or else only staining the rocks upon which it is deposited. The chief metallic element of the gossan is of course iron, though it very often contains a small percentage of copper, and it has often formed an ore of gold and silver, as in the Iron Mountain, Bully Hill, and Afterthought mines.

The term "gossan" appears to be only vaguely understood, and it has generally been applied in northern California without discrimination between the thicker crusts of limonite and the more or less decayed rocks which are only stained with the same material. At Iron Mountain the iron oxide which has resulted from the decay and leaching of the ores has formed in some cases crusts of limonite many feet in thickness. These crusts have a bedded structure characteristic of materials deposited by water. There is comparatively little rock or earthy matter in some of these deposits, and it is evident that they are accumulations of iron oxide carried by means of water from ore bodies of considerable extent. Furthermore, it is evident that iron is one of the chief elements of the ore.

At Bully Hill the surface indications are very different, although the term gossan is likewise applied. Instead of thick crusts of limonite the surface is largely covered by broken and stained masses of rock, often light colored, but containing generally some metallic oxides, perhaps including antimony or zinc. The rock is extensively decomposed and earthy, forming what is often termed "soft porphyry." Such croppings do not indicate an ore that is very high in its percentage of iron. The quantity of gossan found on the surface is generally taken as an index of the quantity of sulphide that has been affected by weathering, and accordingly of the quantity of sulphide that may be expected to be found by development.

As an index to the location of ore deposits, the material

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termed "gossan" is of great importance to the prospector, and a word may be added as to the forms in which it commonly occurs.

(1) There are residual masses of iron oxide *in place,* which have not been removed from the position of the decomposed sulphide.

(2) Iron oxide is carried by circulating waters toward the surface or elsewhere, and deposited as crusts or beds of limonite.

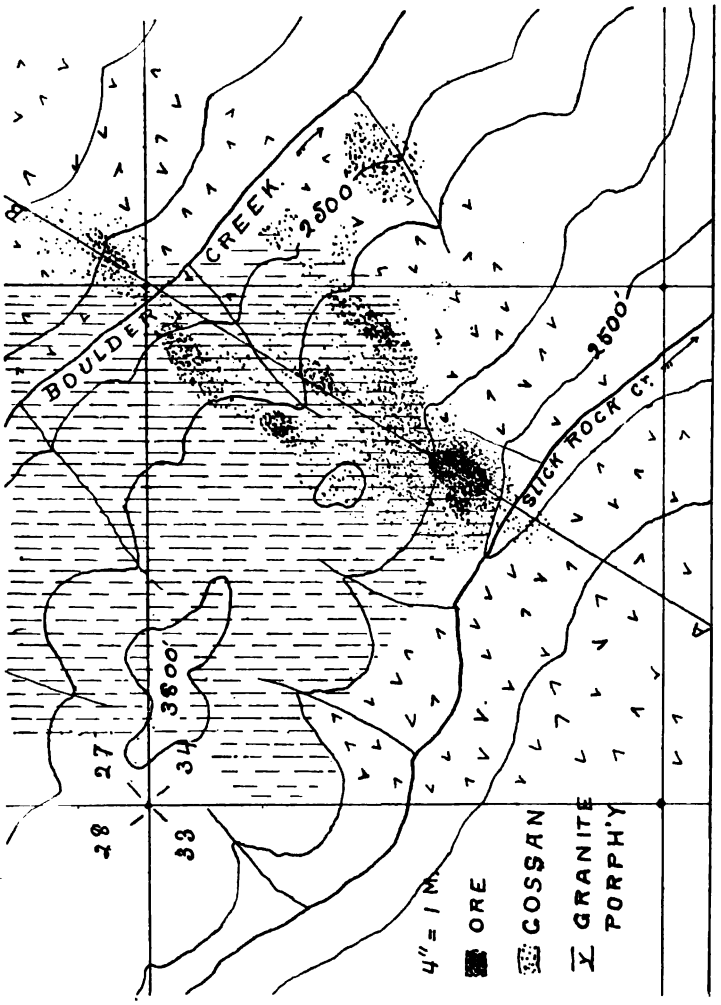
(3) Iron oxide may merely stain the more or less altered country rock, becoming very deceptive as to the quantity and quality of the sulphides from which it has been derived. The sulphates that result from oxidation of iron sulphides react strongly on the country rock, reducing it to the form of white clay and fine white silica, but the oxide of iron may also stain this material to a brownish or dark color.

(4) Much of the so-called "gossan" of Bully Hill is only decomposed rock, consisting of silica and clay which is often only slightly stained with iron oxide.

Secondary enrichment in these ore deposits is very frequent. The leaching of the surface ores results in the formation of soluble sulphates and perhaps other compounds of the metals which are carried downward into the lower portions of the ore body, where richer sulphides are again precipitated. This appears to have been the origin of much of the chalcocite and of the chalcopyrite and other richer ores which are found below the zones of complete and partial oxidation. Such richer ores commonly have a banded structure showing clearly their secondary deposition, which the unaltered sulphides do not appear to have. The depth to which this secondary enrichment has extended varies with the conditions, no doubt. Below the zone of secondary enrichment the ores are usually of lower grade, consisting largely of the unaltered sulphides, which in themselves often become more sparingly distributed. The banding of the ores, that is, the alternating darker and lighter bands that are often found in them, is probably the result of secondary action within the ore body, subsequent to the formation of the ore body itself.

The much talked of ore deposits of Iron Mountain deserve to be particularly noticed in several of their aspects. The

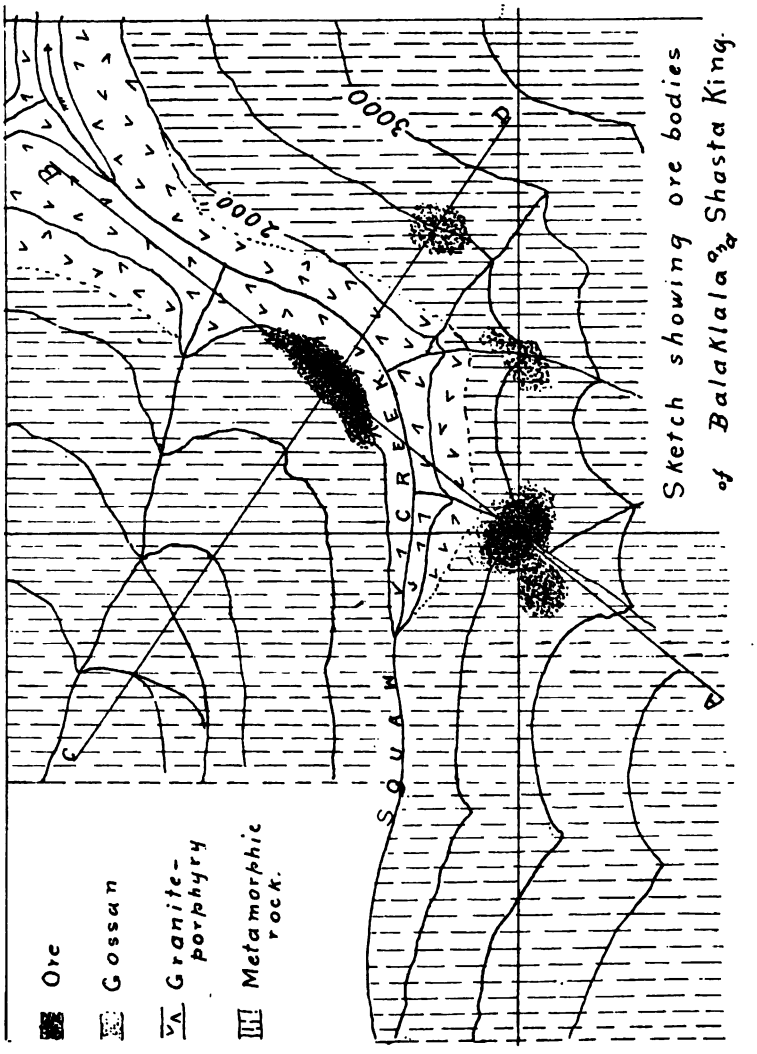
principal one of these lies on the southern slope of the ridge to the north of Slick Rock Canyon, where its position and extent are superficially indicated by an impressive outcrop of gossan. This gossan consists of various materials, the most noticeable



SKETCH SHOWING ORE DEPOSITS OF IRON MOUNTAIN MINE.

one naturally being the iron oxides. The oxides of iron occur as thick beds or crusts of limonite, or as infiltrations or stains mingled with more or less rock and earthy matter. The limonite accumulations have at some points a thickness of more than 30 feet.

As an ore body this deposit of sulphide is roughly lenticular in form, standing in a steeply inclined position, the upper border of which has been truncated by the slope of the hill



Sketch showing ore bodies of Balaklala and Shasta King.

under atmospheric erosion. The longest dimension of the ore body conforms to the strike of the rocks in which it is inclosed, and approximates a length of about 600 feet. Its course is northeasterly. Its vertical depth is something over 300 feet,

and its greatest thickness about 250 feet. It has been described as being "egg-shaped," with its smaller end downward, but this is true only in cross-section. There is comparatively little waste rock contained within its boundaries, and for the most part it could be described as homogeneous sulphide. Therefore, its total tonnage of sulphide has probably exceeded that which has commonly been reported, yet not all of this is to be regarded as ore. In the several levels in which this ore body has been explored the sulphide is not of uniform grade. In an intermediate zone or level, generally spoken of as the "copper level," the ore consists of mixed pyrite and chalcopyrite, and has an average grade probably not below 7 per cent of copper; indeed, some portions of it carry a value above 12 per cent or even 15 per cent in copper. Above this zone is that of partial or complete oxidation, from which the copper contents have been largely removed by leaching. Below the "copper level" the ore is likewise of lower grade in copper, but in this case from a different cause. The "copper level" is a zone of secondary enrichment, below which such action has not been effected. The ore carries considerable value in gold and silver, its gold values ranging above $5 per ton for large masses of ore. Probably none of the sulphide is without its gold content, even when it contains only a trace of copper.

The mineralogy of the ore deposits is a topic for fruitful investigation. The deposits of the eastern and the western districts differ to some extent in their mineralogy as well as in the richness of their ores. Most of the ores of the western district are of lower grade than those worked at the Bully Hill mines, though at the same time they are of much larger dimensions. Large bodies of ore characterize the western district, while high-grade ores are more frequent in the eastern.

The ores of the Bully Hill mines are usually of a dark lead-gray color, in which the dark sulphides of copper and zinc often form the predominating elements. The same is true of the ores found in the workings near Copper City and in the mines of the Afterthought group. The ores contain zinc blende, chalcocite, bornite, chalcopyrite, tetrahedrite, melaconite, and carbonates of copper, with some native copper, silver, and gold. The gangue minerals are barite, calcite, quartz, and residual clay silica and iron oxide.

In the western district, the ores of the Balaklala, Shasta King, Mammoth, Summit, and Golinsky groups, and also of some others, are an intimate mixture of pyrite and chalcopyrite, with occasionally a little zinc blende and some carbonates. In the ores of Iron Mountain there are some of greater value, including bornite and chalcocite. The gangue includes silicious materials, commonly known as quartzite, both east and west; but as the ores are not always connected with sedimentary beds, the silicious material is perhaps largely of a secondary nature.

The Iron Mountain ores comprise the oxides at and near the surface and the deeper-lying sulphides. The oxides carry but a very small percentage of copper, their main values being in gold and silver, for which these ores were at one time worked. They consist principally of ferric oxide, accompanied by a little silica and alumina. Analyses of trial lots have afforded the following:

Sulphur	13.41	2.49
Iron in FeS_2	11.40	2.09
Ferric oxide	48.22	70.88
Zinc	0.24	0.21
Silica	9.45	8.57
Alumina	0.60	1.39
Water	14.00	13.43

The sulphides, which carry as much as 10 per cent of copper in some parts of the mine, are much poorer in gold and silver. One lot of sulphide ore, consisting of 754 tons, smelted in 1896, assayed partly as follows:

Sulphur	45.66
Iron	36.97
Zinc	3.41
Silica	5.60
Alumina	1.57

The total of these figures being only 93.21 per cent, it may be inferred that the remaining 6.79 per cent consists mainly of copper and the precious metals.

Regarding the composition of the ores of the Bully Hill mines less is known, but it is clear that their content of iron is comparatively low, rendering a ferruginous flux necessary, and there is a corresponding increase in the percentage of

zinc, with barytes as a gangue mineral. Antimony and arsenic are also present, though to what extent is not known.

The ores of the Peck, Afterthought, and Donkey mines in the Cow Creek district, which in many respects resemble those of the Pittsburg district, are described as being "very refractory."

MOUNTAIN COPPER MINE.

The Mountain Copper mine, the pioneer copper mine of the Shasta County copper belt, is the old Iron Mountain mine, in the familiar mountain of that name, located between Slick Rock and Boulder creeks, a few miles west of the Sacramento River, in section 34, township 33 north, range 6 west. The property included in the mine proper embraces a number of patented mining claims on the top and sides of the mountain and in the creek canyons. The mountain is here about 7000 feet wide, between the creeks named. The summit of the ridge has an altitude of 3000 feet, and Slick Rock Creek is 700 feet lower. On the apex of the mountain stands a bold outcrop of gossan 300 feet wide, and wide branches of these croppings of iron oxides occur in irregular belts extending laterally toward Boulder Creek.

These gossan ores, from which the copper has been leached out, carry the silver and gold values which prompted and sustained the long and costly efforts at precious-metal mining, of which an account is given in the historical chapter of this Bulletin. The quite extensive development of the mine in former years had silver mainly in view, and the tunnels then run had not quite reached the copper sulphides, which remained to be discovered by later explorations. It was as a silver mine that the property was long on the market until taken hold of in 1895 by a syndicate of London people, who incorporated the Mountain Mines Syndicate, Ltd. This company extended one of the prospect tunnels, encountered and developed a great body of sulphide copper ore, and proceeded to operate the property as a copper mine. Capital was liberally invested in mining facilities, a smelting plant, and a refinery in New Jersey, and the property was, in less than two years, in profitable and successful operation. This discovery and the success that early followed the large-scale

operations, first called wide attention to the copper resources of the great mineral belt to which the mine belongs, and were the start of copper mining in Shasta County. January 1, 1897, the entire property of the Mountain Mines Syndicate was transferred, for $5,750,000, to the present Mountain Copper Company, of London, composed of practically the same individual interests, and with a capital stock of £1,250,000, or about $6,250,000.

The ore deposits of Iron Mountain, specifically described in the section on "The Geology of the Copper Belt," consist of immense lenticular masses of sulphides, mainly underlying the gossan, but in places in and under rhyolite, with no surface indications above. The principal ore mass developed lies in the southern side of the mountain above Slick Rock Creek, and from it the larger portion of the ore mined has come. This ore body was found to be approximately 800 feet long, 100 to 400 feet wide, and 600 feet deep at its greatest depth below outcrop, and was estimated to contain about 1,700,000 tons of ore of all grades. At the date of the transfer to the Mountain Copper Company the ore reserves in sight were estimated at 1,333,183 tons, and other ore bodies have since been developed. The ores are massive iron pyrites carrying an average percentage of copper. The ores carry a large percentage of sulphur, a small amount of silica, and are exceptionally free from arsenic, bismuth, and other elements detracting from the electrical conductivity of the copper.

The mine is opened by thousands of feet of tunnels driven from points high up the sides of the hill, and the ore has been stoped from a large portion of the ore body on the south side.

The numerous buildings at the mine used for all purposes are grouped in Slick Rock Canyon below the mine. The mining plant includes air-compressors for operating power drills, and an electric railway for transporting the ore from the mine to the bunkers at the mine terminus of the steam railroad running to the smelting plant. The latter road is a narrow-gauge line equipped with locomotives, necessary cars, and a complete repair shop. It is eleven miles long, and extremely tortuous in its course, and descends a grade of nearly 2000 feet between the mine and smelter. At the latter place the ore-cars dump from a trestle 20 feet above the level of the yard. At the

mine the cars are loaded in a tunnel, into which chutes lead from ore-bunkers on the hillside.

Owing to the topography of the country no location suitable for a smelting plant could be found nearer to the mine than a point several miles down Slick Rock Creek, and a little over a mile west of the Sacramento River. Here the company at the start established the reduction plant. The private railroad extends to the Southern Pacific line at the river. The early smelting facilities included five water-jacket blast furnaces, one brick hot-air stove to supply hot-air blasts, one Ropp roast-

McDOUGALL ROASTING FURNACE, KESWICK SMELTER, MOUNTAIN COPPER COMPANY, SHASTA COUNTY.

ing furnace, eleven Wright circular calcining furnaces, three briquetting machines, a three-stand converter plant, a sampling plant, and other necessary adjuncts. An extensive foundry and machine shop were among the other features. The capacity of the plant was 1000 tons of ore per day.

When reduction was first attempted in 1896, the pyritic method was tried, under the direction of Herbert Lang. This method was soon abandoned and the ordinary blast furnace method in general use in Montana was adopted. A new plant was installed by H. A. Keller. The capacity was at first 250 tons per day. This was quadrupled by successive enlargements and additions.

The ore, as it comes from the mine, carries about 45 per cent of sulphur. Until 1899 the raw ore was roasted in stalls to remove a large percentage of the sulphur, but in the year mentioned heap roasting in the open air was substituted. A large percentage of the ore, including the fines, was roasted in the mechanical rotary calcining furnaces, which are the patented invention of Lewis T. Wright, the general manager of the properties and operations of the Mountain Copper Company in California.

The plant was arranged on the one-level plan, the site not permitting the terrace arrangement which facilitates the handling of material. The ore floors, cupolas, roasters, etc., were all upon one plane, and hydraulic elevators were used for hoisting to the charging floors, though some of the ore was conveyed directly to the cupolas on elevated tracks. The ore cupolas produced a low-grade matte, probably containing 20 to 30 per cent of copper, and this was in part subjected to another roasting before going to the matte furnaces for still further reduction. The fines from the calcining furnaces, together with the flue dust and other similar material, were bricked by the briquetting machinery for reduction in the various furnaces.

Early in 1902 electric light and power for both smelter and mine began to be supplied by the Keswick Electric Light and Power Company from its generating plant on Mill Seat Creek, 40 miles southeast of Redding, and about 55 miles from the mine. The company owns a large area of timber land on the Pitt River 65 miles from Keswick, and the timber and wood supply is floated down the Pitt and Sacramento rivers to near Keswick. Water for use at the smelter is pumped from the Sacramento River. The company has also extensive holdings of land in the general regions of the mine and smelter. Some of it was acquired for its timber, some for its possible mineral values, and some on account of the destructive influence on vegetation of the sulphur fumes from the burning ore heaps and the smelter.

Many details of interest are necessarily absent from this sketch of the Mountain Copper Company's properties and operations, owing to the limited information afforded the public by the company and its rule that the officers shall not

discuss its business. Its annual reports, however, afford a general knowledge of its operations and give the financial information which measures its success. Production began early in 1896, and during that year 5663 tons of fine copper were produced. The copper production of the four following years is stated by these reports as follows:

	1897.	1898.	1899.	1900.
Ore extracted, tons	165,060	221,895	203,965	179,694
Ore smelted, tons	97,185	168,514	176,689	207,571
Copper matte, tons	7,238	10,721	10,664	11,978
Copper refined, tons	5,958	8,273	11,388	11,443
Copper sold, tons	6,025	8,273	9,647	10,558
Average per cent copper in ore	7.5	6.33	6.04	5.77

It was semi-officially reported that during the first six months of 1901 the amount of ore smelted was 172,783 tons, which would represent something over 8000 tons of fine copper. The quantity of ore smelted during the first half of 1901 was over 80 per cent of the total quantity for the previous year, and had this rate of production been continued through the year a very large annual increase would have resulted. A fire in the mine and other circumstances caused a large falling off in the output of the last six months. The available figures indicate a total of approximately 925,000 tons of ore smelted during the first six years of operation, with an approximate total output of 54,195 long tons of fine copper. This is equal to 121,396,800 pounds.

Custom smelting has been practiced at Keswick since the earliest operations, but mainly upon silicious gold ores. Only to a limited extent have copper ores found their way to these works, except from adjoining counties. Most of the custom work has been for the purpose of obtaining the silicious material required as flux by the smelters themselves. Gold concentrates have been treated generally, but this patronage is not solicited.

Owing to the exceptionally low percentages of arsenic, antimony, etc., the refined product of the Mountain Copper smelter commands a premium in the market for electrical uses. Its conductivity is rated at 101, or more than the standard previously fixed for copper commercially recognized as pure. A paper by Edward Keller, in Mineral Industry for 1900, affords an analysis of a sample of copper matte from the Mountain

Copper Company's smelter, giving the following composition by percentages: Copper, 57.83; sulphur, 22.47; iron, 15.28; nickel and cobalt, .005; zinc, 2.09; lead, .0719; bismuth, .0014; antimony, .0719; arsenic, .013; tellurium and selenium, .006; silver, 13.4 oz. per ton; gold, .51 oz. per ton. This matte, of course, carries the products of fluxing materials. An analysis of the refined product is not available.

Since the publication of the "Copper Resources of California" in 1902, great changes have taken place in the operation of the company's smelter at Keswick. In consequence of the destruction of all vegetation within a radius of several miles from the smelter, the company became the defendant in several suits for damages brought by individual property owners in the neighborhood, and the United States Forest Reserve. An injunction was served against the roasting of the ores, which, of course, interfered with the general plan followed in the treatment of the ores and necessitated a change in the smelting operations.

Roasting in heaps and stalls has been abandoned entirely; of thirteen McDougall roasting furnaces, eight have been removed to the company's chemical works at Martinez. All the eight converters have been transferred to the same place and two of the five matte furnaces were torn down. Of the three remaining, the first one was blown in the latter part of July, 1907, after an extended period of idleness. Metallic copper is no longer produced at the smelter and the matte is shipped to the company's plant at Martinez for further treatment. Instead of 1000 men as before, only 350 were employed at the time mentioned, but it is the intention of the company to increase the capacity as soon as the legal difficulties have been adjusted.

Naturally the suspension of the smelting operations affected the production of the mines, and at the time mentioned only about 150 men were employed in the two principal camps of the company on Slick Rock and Boulder creeks. Improvements, however, have not been interrupted, and preparations are made for an increased output as soon as the ore can be handled at the smelter.

At the Slick Rock Creek camp the change from steam power to electricity has been completed for the entire plant, and

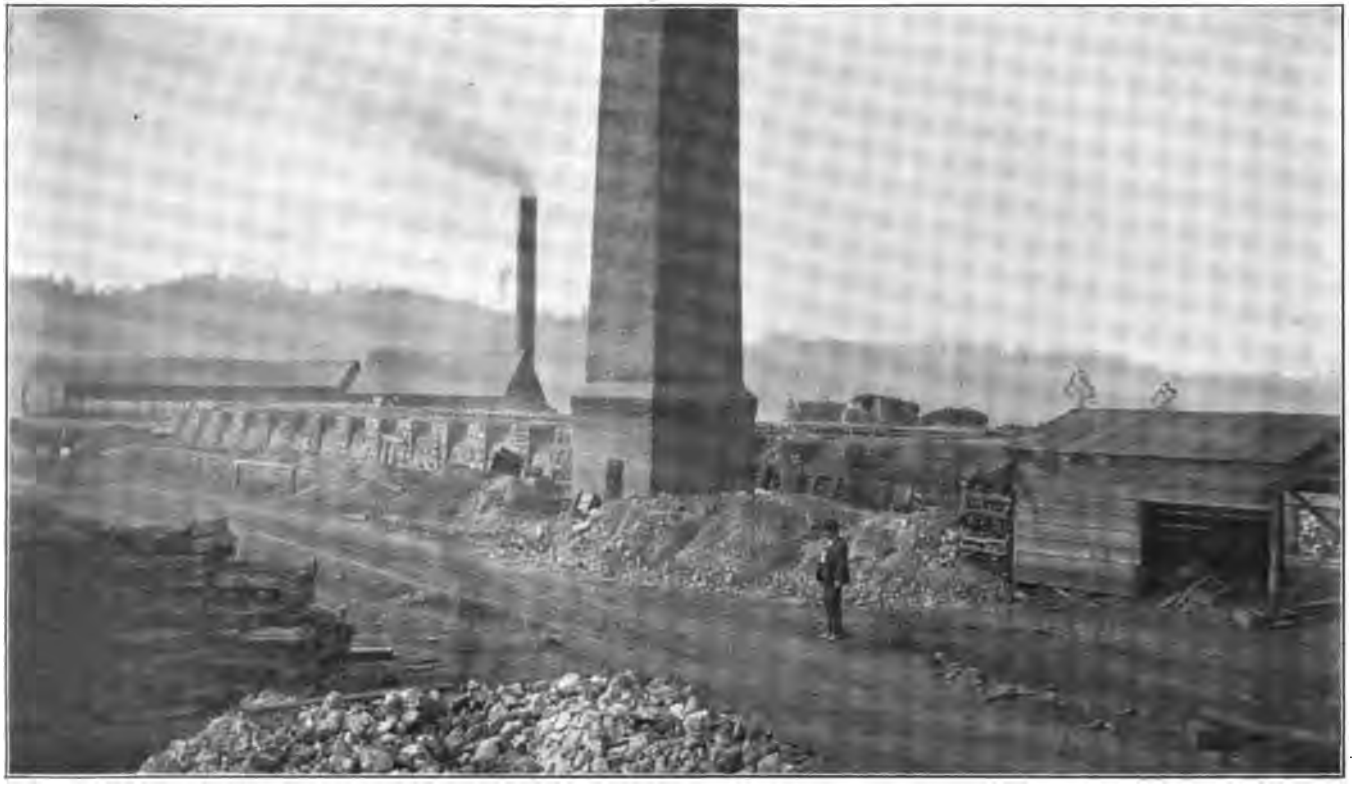
freight is lifted from the railroad cars by an electric hoist and placed on a horse tramway, level with the mines. A building has been erected in which the waters coming out of the mine pass through a series of long boxes filled with scrap iron to precipitate the copper held in solution, and the value saved in this manner is considerable. A light scum floating on the surface and showing bright metallic scales contains 30 per cent copper, while the heavier coating on the iron assays 60 per cent.

On the north slope of Iron Mountain, on Boulder Creek, an immense ore body has been exposed in the Hornet claim, and preparations are being made to work it on a large scale. A heavy gossan running north 30 degrees east indicates the position of the deposit which has been reached by several tunnels, the dimensions of which have not yet been exactly determined. One tunnel, located 300 feet above the creek, follows its eastern edge for over 500 feet; another starts a short distance above the creek and runs the greater part of its length, which is 1600 feet, along the western border. About midway between these two, but on a lower level, has been started the main tunnel, 10 by 10 feet, which will be the outlet for all the ore taken from the mine. The arrangements for handling the ore will be exactly the same as in the Slick Rock camp. Electric cars will haul the ore to a point above a spur of the railroad, whence it will be carried by a gravity road to the bunkers below and loaded on the train that carries it to the smelter. The main tunnel measured 300 feet in July, 1907. It was planned to make accessible a large tonnage of ore.

East of the Hornet on Iron Mountain, and on the mountain north of Boulder Creek, are several outcrops of gossan, which will be prospected by means of diamond drills.

About three miles west of Iron Mountain, in the slate formation, is located the Lone Star group of claims, owned by the Mountain Copper Company. A gossan running southeast-northwest crops out in calcareous shale, and about 400 feet of prospect work, in three tunnels and one winze, has been done, showing small bodies of silicious sulphides.

The Iron Clad Mining Company owns a group of six claims on Clear Creek, township 32, range 6 west, sections 16 and 22. A strong iron dike, which can be traced for some distance, crosses the creek at Coyote Point, and on the eastern bank,



ROASTING STALLS AT BULLY HILL SMELTER, SHASTA COUNTY.

where it shows a strong gossan, an open cut exposes a vein about 12 feet wide, carrying iron and copper sulphides. The company has started a new shaft on the west bank of the creek. J. O. Gilson, French Creek post office, has charge of the property (1908).

Maruce, Lynch et al. have located six claims on an iron outcrop near Whiskeytown and run two tunnels of 138 and 110 feet, intended to cut the vein 150 feet below the surface.

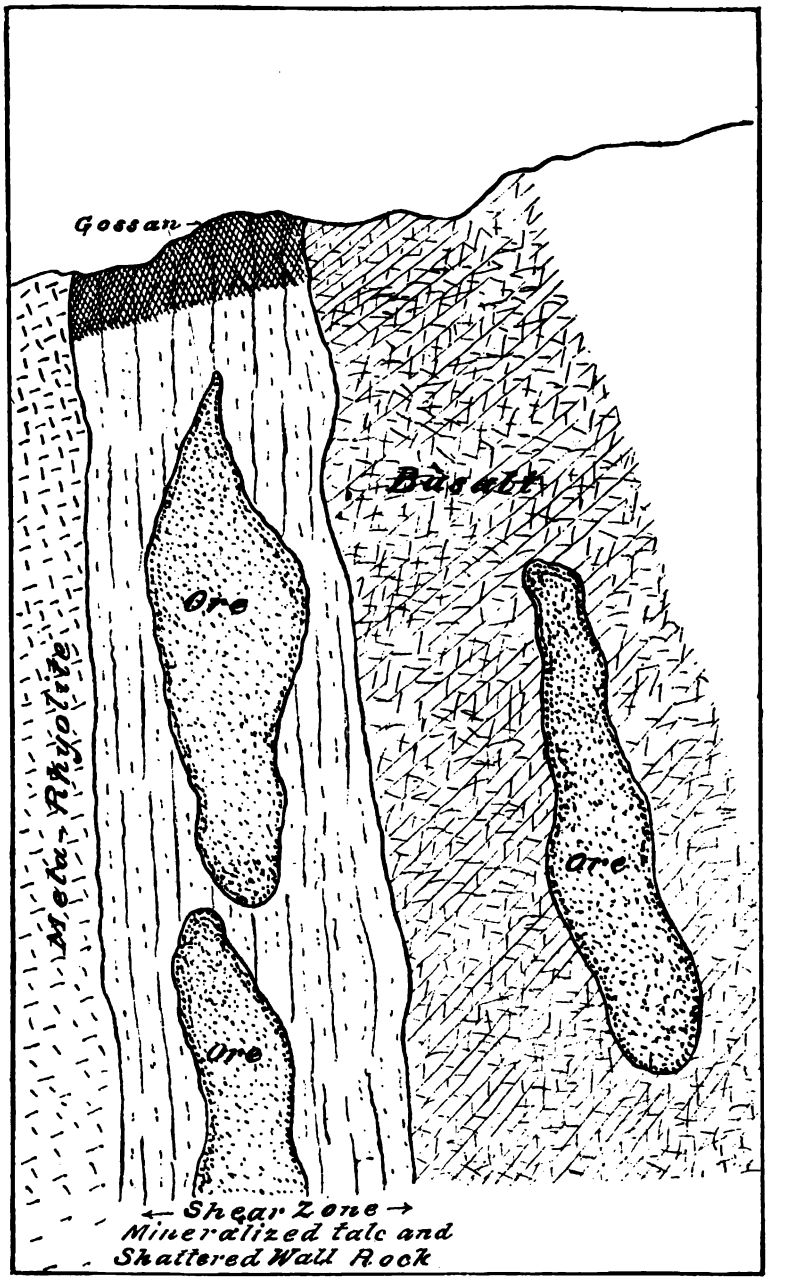
At the head of Motion Creek, west of Copley, have been made a number of locations on iron outcrops, which are very similar to those of the Iron Mountain in the south and the Balaklala on the north.

BULLY HILL MINE.

This property is situated nearly twenty miles in a direct line north of east from Iron Mountain and well toward the eastern end of the copper belt. The Bully Hill is an old property, which, like the Mountain Copper, was long ago and for a good while mined, with little or no success, for the gold and silver in the gossan near the surface. During the first years of the operations of the Mountain Copper Company this property underwent extensive exploration, which developed important ore bodies justifying the expensive further development and the installation of mining and smelting plants which followed.

The Bully Hill property includes (1908) seventeen lode claims and one placer claim, all patented, aggregating 213 acres. It stretches for about two miles in a northeasterly direction, close to Squaw Creek and but a little north of Pitt River. It is in sections 15, 16, 21, 22, and 28, township 34 north, range 3 west. It is near the old town of Copper City, and the new town Delamar adjoins. About 1899, on the strength of the showing made by tunnels driven by James Sallee, the property was bonded by J. R. De La Mar, and after further development was purchased by him for $225,000. In 1901, the property was transferred to the Bully Hill Copper Mining and Smelting Company, of which Mr. De La Mar was president. It is now controlled by the Western Electric Company.

The Bully Hill mine lies in a formation classified as meta-



California State Mining Bureau.

CROSS-SECTION OF BULLY HILL MINE, SHASTA COUNTY.*

*By J. J. Kruttschnitt, Jr.

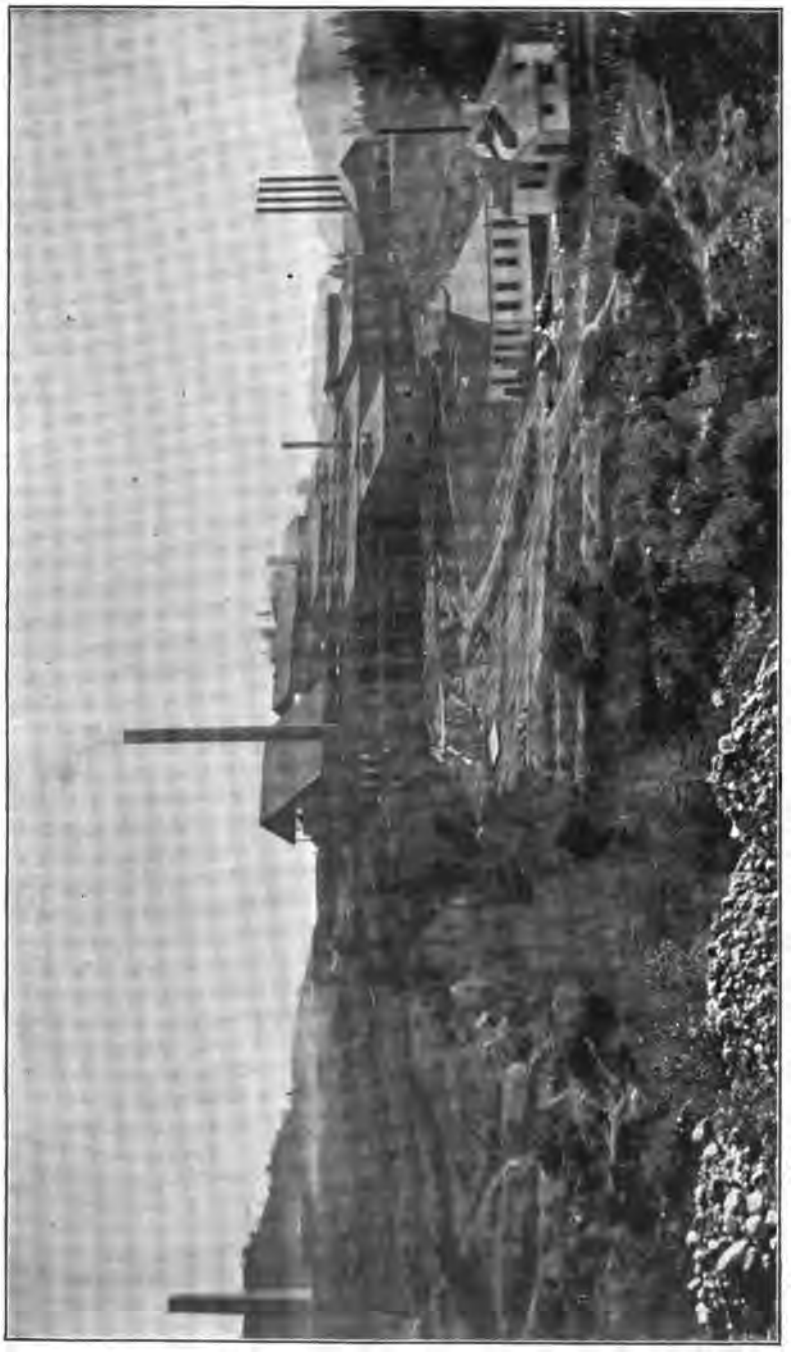
rhyolite. The ore is found in veins trending east of north, with an almost vertical dip to the east, varying in width from 4 to 400 feet, averaging about 30 feet. The eastern wall is formed by basalt and the vein between the two formations is considered a shear-zone, being filled with mineralized talc and shattered wall rock. Two main parallel bodies have been exploited in the lode claims and one in the Popejoy placer claim. The ore occurs in irregular lenticular bodies, connected by narrow seams of ore, attaining a width of 45 feet and a length of 200 feet. In the basalt wall are found ore deposits fully equal to those occurring in the vein.

Copper oxides (cuprite, malachite, etc.) are found in the upper levels, changing into copper glance, bornite, with depth, and chalcopyrite in the lowest levels. The ore is of a complex and refractory nature, carrying zinc, antimony, etc., and (as stated by good authority) enough gold and silver to constitute about half the value of the matte so far produced.

The mine has been opened by a number of tunnels with extensive drifts, crosscuts, upraises and stopes, comprising many thousand feet. The lowest tunnel, No. 3 level, was run as a crosscut and struck the vein at a distance of 1100 feet and about 600 feet below the gossan outcrop. At this point a station of 100 feet square has been established, and extensive hoisting and pumping machinery has been installed for the purpose of continuing exploration at greater depth. A shaft, well timbered, with three compartments and two cages, has been sunk to a depth of about 600 feet below the apex, and a number of levels extend from it along the vein. The ore held out so well in the lower workings that the company intends to continue sinking. It was originally believed that the basalt was barren at this depth, but the good showing seemed to disprove this assumption, and a 130-foot drift was run from 5th level into the basalt, with the result that an exceedingly large and rich deposit was discovered.

No. 3 level is connected by chutes and upraises with the upper workings, of which some drifts run along the vein 800 and 1000 feet. The mine is timbered by the square-set system. Mining timbers are floated down Pitt River from the timber region to the northeast, as is most of the cordwood used for fuel at the power plant and the roasting stalls.

Development work (1908) is constantly going on at the



SMELTER AT THE BULLY HILL MINES, SHASTA COUNTY.

rate of about 600 feet per month, and massive bodies of unusually rich sulphides are being opened with remarkable consistency. The lowest tunnel, level No. 3, is connected by a railway with the well-equipped smelting plant one mile distant, which began operations in May, 1901. The raw ore is first roasted in stalls, built on the hillside near the smelter, forming a stone structure 39 by 310 feet with a brick stack 90 feet high, connecting with the stall flues. The smelting plant cost about $200,000, and included one water-jacket furnace 42 by 120 inches, two calcining furnaces, five converters for bessemerizing the matte, a machine shop, etc. The furnace charge usually consists of about one half raw and one half calcined ore. The charge carries 8 to 10 per cent coke, 2 to 3 per cent limestone, 1 to 1½ per cent ironstone, and the balance ore. Limestone and iron for fluxing are obtained on the McCloud River, about six miles distant. Sufficient silica is obtained from the mine.

The furnace produces a matte carrying from 35 to 55 per cent copper, which is taken directly to the converters in a ladle handled by an electric crane having a capacity of 20 tons. The converters are 68 by 98 inches in size and have a capacity of five tons. The product of the converters is blister copper about 98 per cent fine, which is cast into large rectangular slabs for shipment to the refinery built by Captain De La Mar on Kill von Kull, near New York City. Mining and reduction cost values and output are not obtainable.

The power for the mine and smelter is furnished by the California Power Company, which has transmission lines running to Bully Hill from three of its generating stations. The voltage of these lines is 35,000 volts.

The company has constructed (1908) a standard gauge railroad from De La Mar through Copper City to Pitt, a station on the Southern Pacific Railroad, two miles above Kennet, of great economic value, because heretofore the company had to carry all its freight to Bella Vista, to the line of a private railroad. The Bully Hill Mining and Smelting Company purchased and bonded other properties on the belt of which the most important was the old Baxter and Winthrop group near Copper City, ranking (in 1908) fourth along the whole belt in the amount of development.

CHUTE BETWEEN TUNNELS Nos. 2 AND 3, ELECTRIC POWER HOUSE, AND TIMBER SHEDS, BULLY HILL MINES.

VIEW OF BULLY HILL SMELTER FROM MOUTH OF No. 3 TUNNEL.

OTHER PROPERTIES.

The remaining properties of the copper belt are noted successively, beginning at the western end.

Mineral Mountain.—This property consists of six unpatented claims about three miles south of Iron Mountain, in section 13, township 32 north, range 6 west, and has been thought to mark the southwestern terminus of the belt. No other mining claims carrying copper deposits worthy of any note were known to exist south of the Mountain Copper mine in Iron Mountain in 1908. The Mineral Mountain group is owned by D. T. Callahan et al., and about 200 feet of tunnel shows sulphide ore. There are surface indications of other bodies.

Sugar Loaf (Galvin) Group.—This property is located immediately northeast of the holdings of the Mountain Copper Company, and shows the first prominent outcrop on the belt, after leaving the Iron Mountain mines. The property consists of seventeen claims, pending patent, in sections 25 and 26, township 33 north, range 6 west, located on Sugar Loaf Mountain, one of the most prominent landmarks of the copper belt. The formation is the same as that encountered elsewhere on the belt. Large croppings of gossan, in places 400 feet and over in width, indicate the presence of ore bodies in the rhyolitic rock. The development work consists of 12 tunnels, aggregating 4365 feet. A very distinct fissure, bearing approximately north and south, has been followed about 1000 feet in tunnels Nos. 2 and 5. Small pockets of sulphide ores were encountered, but no definite ore body has as yet been discovered. From 20 to 30 men are constantly employed, and an electrically driven air compressor is being installed. The property is owned by the Copper Mountain Consolidated Mining Company of Redding, Mr. John Pillius, president; F. G. King, vice-president; Fred Grotefend, secretary and treasurer.

King Copper Group.—The King Copper group, consisting of twenty-two claims in sections 23, 24, 25, and 26, township 33 north, range 6 west, adjoins the Sugar Loaf on the northeast and is the property of the Trinity Copper Company. It is located two and a half miles south of the Shasta King, the

main Trinity Copper Company holding. The development consists mainly of assessment work and approximates 1000 feet of openings in the aggregate.

Jumping Jack.—Five claims adjoining the King Copper on the east, in sections 24 and 25, township 33 north, range 6 west; owned by William Kendrick, of Copley.

Giant Consolidated.—Thirteen claims on the eastern edge of this part of the belt, north of the Jumping Jack, in section 24, township 33 north, range 6 west, and section 19, township 33 north, range 5 west; owned by W. H. Soderberg et al., San Francisco.

King.—Four claims in section 24, township 33 north, range 6 west; owned by J. R. King, of Copley.

United Copper.—Eighteen unpatented claims in section 23, township 33 north, range 6 west, adjoining the King Copper on the north and west; owned by Fred Grotefend et al., Redding.

Webster Consolidated (Stowell) Group.—The Webster Consolidated, or Stowell, group consists of seven patented and three unpatented claims, located in section 14, township 33 north, range 6 west. The property is one of the older mines on the West Side belt, and is about three and a half miles northeast of Iron Mountain. The development (1908) consists of a series of short crosscut tunnels aggregating 500 to 600 feet in all, none of which has reached the objective point. The J. H. Stowell Estate, owner.

Waters Group.—The Waters group is located in section 14, township 33 north, range 6 west, and consists of four claims. They adjoin the Webster Consolidated on the south, and some of the development work done was intended to reach the vein on the neighboring property at greater depth. Its location is such that it will prove of value to the adjoining holdings, and when developed the properties will probably be operated as one mine. L. Waters and E. A. Marshall, of Redding, owners.

Spread Eagle Group.—Twenty-seven claims, non-patented, in section 13, township 33 north, range 6 west; owned by W. G. Onn & Sons, of Copley, under bond to the Shasta

County Exploration Company, of which Mr. M. E. Dittmar is managing director, with offices in Redding. The development work consists of eight tunnels, aggregating about 3000

SHASTA KING MINE, TRINITY COPPER MINING COMPANY, SHASTA COUNTY.

feet. In tunnel No. 7 three small stringers of sulphide were intercepted.

Loraine Group.—Twenty-two claims adjoining the Spread Eagle on the northeast, in sections 7 and 18, township 33 north, range 5 west; owned by D. Endicott, T. J. Foley, M. E. Arrighini, and the Balaklala Consolidated Company, which owns one-fifth interest in the property.

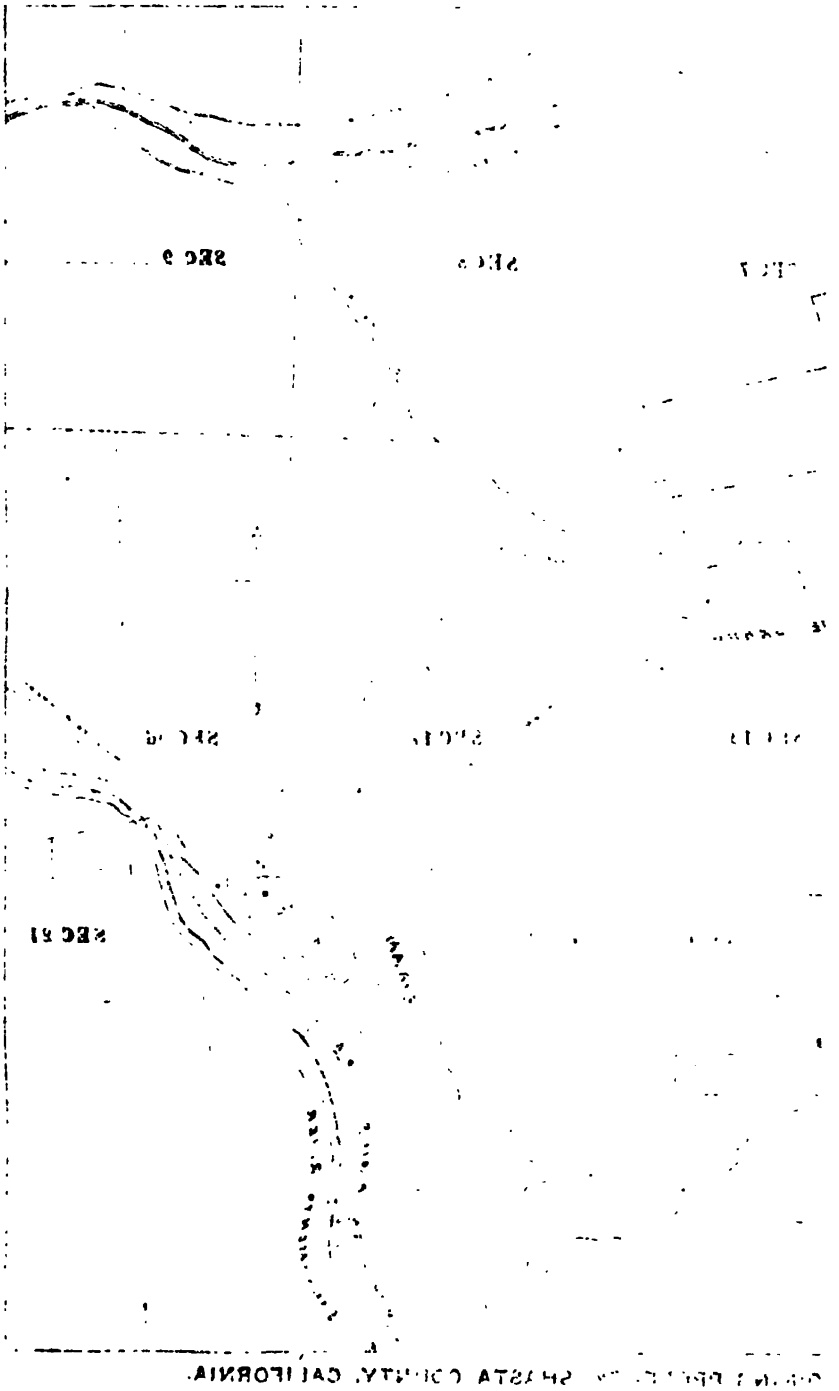
The Shasta King Mine.—The Shasta King mine constitutes the principal holdings of the Trinity Copper Company, a Boston corporation (Thomas W. Lawson, president), and is capitalized for $6,000,000. The Shasta King consists of twenty-two patented claims in sections 11 and 12, township 33 north, range 6 west. Besides this property the company owns a number of patented claims, known as the Lawson Butte, in sections 24 and 26, township 33 north, range 6 west; 580 acres on Squaw Creek, 800 acres of placer mineral and timber lands, 400 acres of patented ground on Motion Creek, near Copley, that was at one time spoken of as a possible smelter site. Owing to the fact that men, both competent and incompetent to pass equitable judgment on the economic value of the mine, were allowed access to the workings, opinions of a conflicting and sensational nature were given publicity which affected the entire copper producing district, and the officers of the company adopted a stringent policy regarding the admission of visitors to the mine. Thus admission to the underground workings was denied, but the surface indications were inspected and information was tendered by the officers which made the compilation of this report possible. The property was developed under bond for a year and a half prior to its purchase by the Trinity Copper Company, and at the time of its acquisition, it was reported that a large tonnage of ore was opened up in the mine. It is reported that the values in the ore averaged 5 per cent copper and about $2.50 to $3 in gold and silver. The company acquired the Shasta King toward the close of the year 1900, and early in the following year commenced development work on a large scale. The property was opened up mainly by tunnel levels, aggregating several thousand feet in length. This series of tunnels crosscut the ore body on the main level for a distance

of 1000 feet around the mountain side, and these have been connected by drifts along the foot wall. The large ore body of a massive sulphide character, with a dip but slightly deviating from the horizontal, outcrops on the mountain side, forming one half of Squaw Creek canyon, which course at the mine is east and west. The gossan croppings are very prominent, and can be followed several thousand feet. The Shasta King faces the Balaklala, but it is several hundred feet below it. A double track incline tram 850 feet in length, and having an average angle of 42 degrees, was constructed to handle the ore from the mine to the Balaklala aërial tram connecting that mine with the reduction plant at Coram. However, large shipping bins have been built at Coram so that the company can ship its ore pending the completion of the local smelter. A large bin capacity is supplied at each ore handling terminal from mine to smelter. The company expects to prospect the Lawson Butte group with diamond drills. The mine is equipped with model and commodious bunk and boarding houses. Austin H. Brown is general manager, with offices at Kennet.

THE BALAKLALA CONSOLIDATED COPPER COMPANY.

In 1902 the Western Exploration Company secured a bond on the property owned by this company and carried on extensive development work until 1905, when it passed into the hands of the present management. Since then the exploration of the ground has been continued and extensive improvements have been made preparatory to the extraction of the large ore bodies, the existence of which had been determined by the preliminary work.

The property consists of more than seventy patented claims, aggregating nearly 1500 acres, situated in Flat Creek Mining District, Shasta County, in sections 11, 12, 13, and 14, about three miles from Coram Station on the Southern Pacific Railroad, between Redding and Kennet. The mines are located on the south side of Squaw Creek, at an elevation of 2400 feet, on the steep slope of a mountain rising to 3650 feet above sea level. Below the mines the creek runs in a narrow canyon, about 700 feet deep, with very precipitous slopes, near the bottom of which on the opposite side are the tunnels of the



SHASTA COUNTY, CALIFORNIA.

Shasta King, belonging to the Trinity Copper Company. The camp is situated between Windy Gulch in the west and Mule Gulch on the east, close to the latter. It is well equipped with everything necessary to operate the mines on a large scale. The pay roll showed 164 names in 1908, but accommodation was being made for a much larger force. Wood and water are abundant, and a good wagon road leads to Coram, about six miles distant.

The formation is described in the report of the United States Geological Survey as meta-rhyolite, extensively folded

BALAKLALA CONSOLIDATED COPPER MINING COMPANY SMELTER, CORAM, SHASTA COUNTY.

and faulted. The ore occurs in flat bodies with a slight dip to the north and the greatest extension nearly east and west. A series of step faults from north to south, running east and west, have caused a displacement of the ore bodies from a few feet to 100 feet and more. The ore bodies farthest west, on the Early Bird, the Copper Alps, and the El Capitan claim in Windy Gulch, occupy a horizon more than 100 feet above the Weil tunnel deposit, and the ore in the Shasta King is several hundred feet lower than the latter. Besides the faults there are fissures running north and south through Windy Gulch and Mule Gulch, which define the ore bodies. These

fissures are supposed to have affected the ore bodies, which increase in size and improve in quality in their neighborhood.

The ore is a hard, heavy iron sulphide, carrying chalcopyrite, a little glance, covellite and a little gold and silver. Iron varies from 31.6 to 42.2 per cent and silica from 23 to 55 per cent.

The locations cover over 3000 feet on the strike of the lode, and besides some undeveloped prospects two large separate ore bodies are known, one near Mule Gulch, the other in the vicinity of Windy Camp. The latter was discovered first, its eastern portion cropping out on the mountain side where about 40 feet of ore are exposed and a number of tunnels were run into it, two of which were 900 and 1000 feet long. It is known to measure 900 feet on the strike, varying in thickness from 20 to 60 feet. The ore is reported as assaying:

Gold	.025 oz.
Silver	.85 oz.
Copper	2.46%
Silica	23.5 %
Iron	29.8 %

There is a possibility that new ore bodies may be found farther west, good ore having been discovered on the Early Bird and Copper Alps claims. The eastern body, near Mule Gulch, was discovered by means of the diamond drill, and developed through the Weil tunnel, which reaches it at 750 feet. Upraises were made through its entire thickness and drifts run on both sides until the walls were struck, and in this way the dimensions were found to be approximately 1200 feet in length from east to west, 300 feet in width north and south, and from 20 to 40 feet in thickness. At No. 1 raise the ore lies 95 feet above the tunnel, at No. 4, 720 feet west of No. 1, 20 feet, showing a decided pitch in that direction. This ore is reported as assaying:

Gold	.0228 oz.
Silver	.82 oz.
Copper	2.734%
Iron	29.10 %
Silica	29.80 %

The cost of mining is estimated at $1.75 per ton. Ore blocked out, 1,051,555 tons; ore estimated, 1,040,894 tons; total, 2,092,449 tons. These figures are taken from a report

GOSSAN CROPPINGS AND TUNNEL, BALAKLALA MINE, SHASTA COUNTY.

on the property by Duncan Macvichie, for which we are indebted to the courtesy of the Balaklala Consolidated Copper Company.

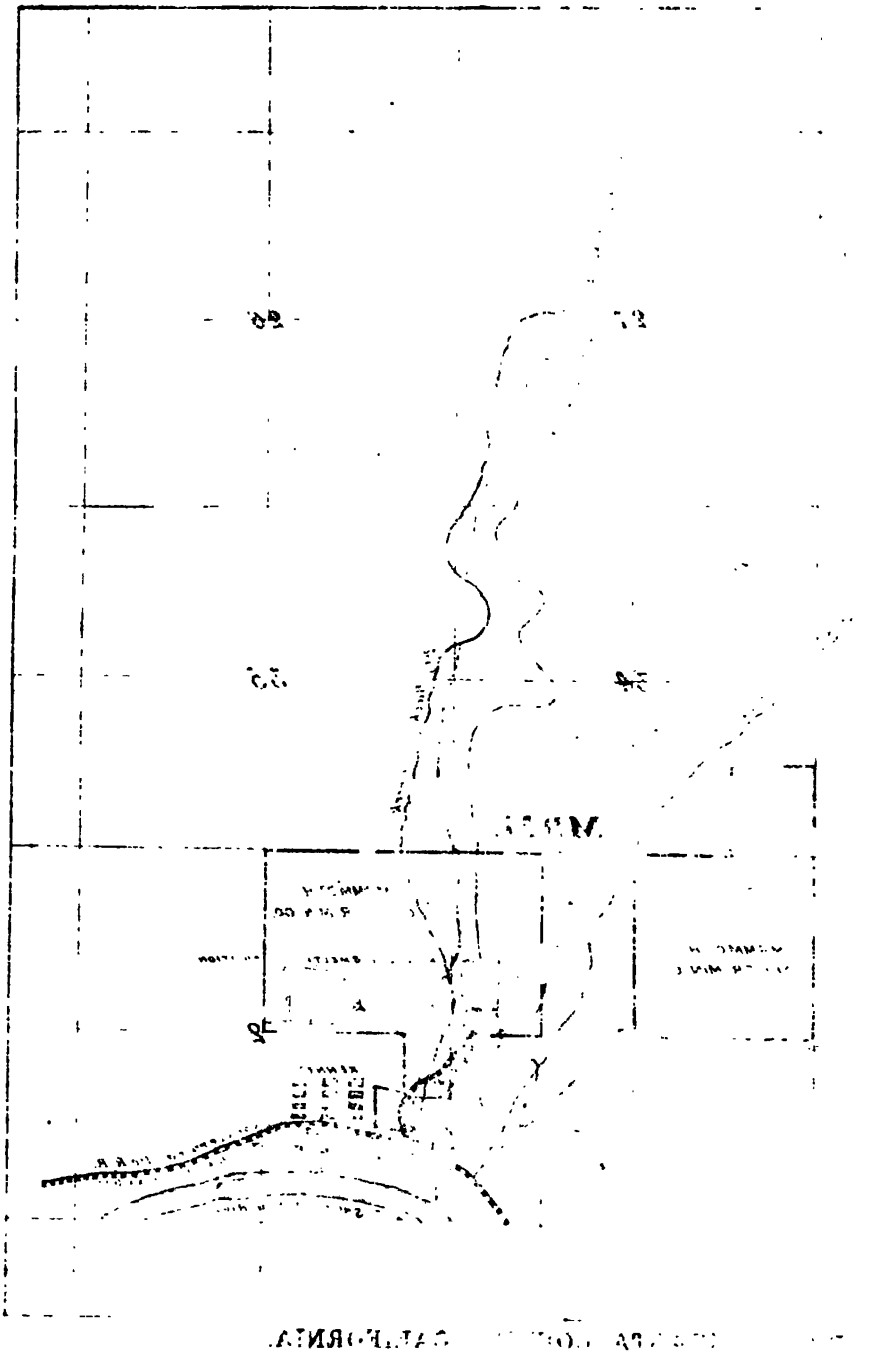
A drift has been run from the Weil tunnel towards the Windy Camp deposit, from which a 240-foot upraise opens in front of tunnels Nos. 8 and 10. It is the intention to carry all the ore from this part of the mine to the Weil tunnel, from which it will be hauled by electric cars to the bins at the terminal of the wire tramway. Here it is reduced to the size of 4 to 5 inches and loaded into the buckets which deliver it at the smelter. The tramway is of the Riblet system, 16,130 feet in length, with a capacity of 75 tons per hour. An arrangement has been made with the Trinity Copper Company to carry the ore from adjoining property over this tramway to the smelter or the railroad station, and for this purpose a gravity road 800 feet long has been built from the ore bin down the steep slope to the bottom of Squaw Creek Gulch, where it connects with the main tunnel of the Shasta King.

The Balaklala Company has constructed a large smelter at Coram Station on the Sacramento River, township 32 north, range 6 west, sections 20 and 21, nine miles north of Redding, which is nearly completed. The principal structures of the plant are the furnace house, the blower building, the matte and roaster buildings, dust chamber and smokestack, ore bins and the usual accessories, machine and repair shops, assay office and laboratory, general offices, residences, etc. The furnace house contains a reverberatory smelting furnace and three matte blast furnaces.

The reverberatory furnace is 90 feet long by 15 feet 6 inches wide inside, and oil is used as fuel. The waste heat is utilized to generate steam power in two Sterling boilers.

The matte furnaces are of the largest size, 56 by 240 inches between tuyeres, of which there are 20 on each side, and 18 feet high from bottom to feed floor. Water jackets form the walls from the bottom to the feed floor, and except a 12-inch layer of fire brick in the bottom, no material but iron is used in the construction. The capacity of each furnace is at least 400 tons per day.

The furnaces stand on an elevated floor, which facilitates the handling of the product. The slag is tapped into large



MAMMOTH MINE, SHASTA COUNTY.

iron pots on wheels and hauled by electric engines to the dump. The matte runs into iron pots which are lifted by an overhead electric crane and carried to the matte house, where it is cast into iron molds and put on railroad cars, if rich enough for shipment, or returned to the furnaces if too poor.

A separate building contains four McDougall roasting furnaces of 50 tons capacity each. They are not provided with fireplaces, only a little fuel being required at the beginning to start the combustion, which afterwards is kept up by the sulphur in the ore.

Three 300 cubic feet Root blowers furnish the blast for the furnaces, each driven by a 450-horsepower tandem compound steam engine, directly connected. Steam power is supplied by five Sterling boilers, for three of which oil is used as fuel, while two are heated by the gases from the roasting furnace. Blast pressure will be about 36 ounces.

One large building contains the bins for receiving ores and the sampling floor, and on the level with the feeding floor of the furnace house is a row of bins 500 feet in length, from which the ore is carried in cars to the feeding doors of the furnaces. Part of these bins contain the fluxes necessary for smelting the ores.

Large dust chambers carry the smoke and fumes from the roasters and furnaces to a smokestack 250 feet high, on top of the hill, an elevation which is deemed sufficient to avoid evil consequences.

When the ore arrives from the mines it will pass through 4 by 10 feet revolving sizing drums, and the coarse material goes to the blast furnaces. The fines are roasted in the McDougall furnaces, and with flue dust are smelted into matte in the reverberatory furnace.

Ohio Consolidated.—Patented claims in section 12, township 33 north, range 6 west; owned by Morton & Bliss, New York. No development.

Friday & Lowden Group.—The Friday & Lowden group consists of thirteen claims, located in sections 5 and 6, township 33 north, range 5 west, and also that portion of the northwest quarter of section 5 and the north half of the southwest quarter of section 5 not included in the mineral locations.

This part of the land is patented. This group of claims is the first encountered on the copper belt on the north side of Squaw Creek, and is directly east of the gold belt in which the Uncle Sam mine is located. The geological conditions, however, are similar to the conditions encountered in other parts of the copper territory. The mine is opened mainly by means of tunnels. A crosscut tunnel driven on the northerly end of the group, on the Cleveland claim, is in ore. A second tunnel has been started 175 feet deeper. On the Wild Bear claim easterly from the main development a 70-foot tunnel discloses considerable ore, and a shorter tunnel 250 feet farther along the strike is also in ore. On the common end line of the Wild Boar and Comstock claims a tunnel 65 feet in length shows some sulphide, after penetrating the gossan or oxidized ore, the latter prospecting in free gold. The total tunnel openings aggregate fully 800 feet in length. The strike is northeast and southwest, and the croppings occur at an altitude of about 2000 feet. Messrs. Friday and Zowden, of Redding, owners.

MAMMOTH MINE.

This property is situated in the Backbone district, in the most northerly portion of the copper belt, four miles north of west of Kennet; elevation, 3000 feet, or 2200 feet above that place. It consists of twenty-five claims and fractions in sections 32 and 29, and part of sections 31 and 33, township 34 north, range 5 west, and some land in sections 2 and 3, township 33 north, range 5 west, in all about 1900 acres, patented. It is owned by the United States Mining and Smelting Company of Boston, but is operated as the Mammoth Copper Mining Company; Fred Lyon, manager, post office Kennet.

Formation and character of ore are the same as in the other mines of the western part of the Shasta County copper belt. A gossan outcrop, 200 feet wide, can be traced 800 feet, and the underlying ore bodies, which are reported to be very large, are opened up by numerous tunnels, drifts, etc., aggregating about 14,000 feet. The lowest tunnel, the Coleman level, serves for hauling the ore from all parts of the mine to the surface. In working the mine the caving-in plan is used; after removing the ore from a certain area the empty

stope is filled by shooting down the roof. The effect of this method is seen on top of the mountain above the mine, where the ground has caved in many places and is crossed by numerous fissures.

After the erection of the company's smelter the output of the mine, amounting to about 500 tons per day, was transported to the smelter over an aërial wire tramway, Riblet system, 13,000 feet in length; but when the planned enlargement of the smelter is completed, this quantity will be inadequate to supply the increased capacity and a change in the transportation system will be made. The mines will be equipped with an electric railway, 3-foot gauge, 2 miles long, which will carry the ore to the head of a gravity road 4000 feet long, with a drop of 1700 feet. This road will have a gauge of 4 feet 8 inches, a double track, and skips of 20 tons capacity each. From the bins at the bottom of this road the ore will be loaded into ordinary railroad cars and carried 2 miles to the smelter. Oil is used as fuel for the locomotives and the cars are bottom dumping.

The mine is equipped with all the buildings and mechanical devices necessary for operations on a large scale, offices, dwelling houses, air compressors, sawmill, blacksmith and repair shops, etc.

The smelter, built in 1905, is located one and one half miles from Kennet, near the Southern Pacific Railroad, and connected with it by a spur. It has three blast furnaces, 42 by 180 inches at the tuyeres, steel water-jacketed, provided with both side and end doors; joint capacity about 1000 tons of ore and fluxes per day (75 per cent ore, 25 per cent fluxes and furnace by-products), which are fed mechanically, with exception of the coke. The smelting is semi-pyritic, the ore being smelted without roasting and with a low percentage of coke. Cold blast of 42-ounce pressure is supplied by three Connersville cycloidal blowers, belt driven by three 200-horsepower alternating current motors. The furnace settlers are of the continuous flow syphon type, and the matte is discharged from the spouts upon a traveling matte casting machine and when chilled is dropped into wheelbarrows.

The smoke from the furnaces passes through a 200-foot flue into a dust chamber 60 feet long, 456 square feet area, and

escapes through a steel stack 12 feet in diameter, 150 feet high. The flue dust is mixed with some fine sulphide ore and made into bricks by a briquetting machine of a capacity of 6 tons per hour.

In 1907 the company commenced with the enlargement of the plant, which necessitated a change in the transportation of the ore from the mine. Two new blast furnaces, constructed like the old ones, 50 by 180 inches between tuyeres, will be erected and two converter stands, each of four Allis-Chalmers improved 96 by 150-inch converter shells, will be added. Instead of shipping the matte to the company's works at Bingham, Utah, as has been done heretofore, in future it will be resmelted until rich enough to be refined in the converters. Four additional Connersville blowers, each driven by one 225-horsepower general electric motor, will be installed and a Nordberg converter blowing engine of 750-horsepower.

The present storage capacity will be increased many thousand tons by the addition of a number of new ore bins, and dust chamber and smokestack will also be greatly enlarged. Water is obtained from Big Backbone Creek by a ditch and flume and delivered at the smelter under 60 pounds pressure. More than 1000 men are employed at mine and smelter.

Mayflower.—Six unpatented claims in section 32, township 34 north, range 5 west; owned by C. G. Ferguson and B. Golinsky, of Kennet. A little development work has shown some high-grade ore.

Bohematosh.—Seven claims in section 25, township 33 north, range 6 west; owned by Walter Friday and J. R. Lowden. Disseminated sulphides are abundant, with extensive croppings of gossan. This is several miles north of the definite limits of the belt proper.

Summit Group.—This property consists of thirty unpatented claims located on the eastern slope of Bohematosh Mountain, on a ridge lying between the north and south fork of Little Backbone Creek, in section 30, township 34 north, range 5 west, at an elevation of about 3000 feet, and adjoins the Mammoth Company's property on the west. The Graves, Summit, and North Mammoth Extension groups comprise the Summit holdings. The ground is very regular, the formation

being the same in character as the more southerly part of the belt. The country rock is heavily mineralized and the surface indications are very pronounced in this part of the belt. The strike of the ore can be readily traced around the mountain side for fully 2400 feet. Three tunnels have been driven, one on the northeasterly, one on the southerly, and one on the westerly portion of the ground. No. 2, the main tunnel, is in about 400 feet and an upraise is driven at 350 feet, which is about 50 feet high at present, to determine the foot wall of the sulphide ledge encountered in the floor of the upper tunnel, No. 1. The ore body, which appears to lie between tunnels Nos. 1 and 2, has a shallow dip to the northwest. Prospect shafts sunk in the croppings above tunnel No. 1 indicate a width of at least 35 feet, with ore reported to assay 8 per cent copper; the sulphide ore from the tunnel is reported to contain from 6 to 14½ per cent copper. The first 90 feet of tunnel No. 1 was driven through a secondary deposition caused by leaching of the ore body and carrying values throughout. The next 50 feet passed through a quartzite foot wall, intersected with numerous seams bearing sulphide ore, varying from a few inches to a foot and a half in width. Between the foot wall and the solid sulphide body a breccia carrying a high percentage of copper sulphide was encountered. Tunnel No. 3, situated at some little distance from Nos. 1 and 2 and driven nearly west, is in 400 feet, following a contact of rhyolite and porphyry. Ore has been found here, but more or less in a disseminated state. Total development about 1200 feet. Water and timber in abundance are on the ground. The property is under bond to the Stauffer Chemical Company of San Francisco, which has installed a Sullivan compressor with a capacity of four drills. Superintendent, Chas. Kunze; post office, Kennet.

Ferguson & Limbough.—This group, in section 4, township 33 north, range 5 west, is developed by 165 feet of tunnels showing some ore.

Great Verde.—Twelve claims, four of which are patented, in sections 11 and 12, township 33 north, range 6 west; owned by the Vulcan Mining Company, John Lyle, of Dunsmuir, president, and W. T. Shaw vice-president. This property

MAMMOTH COPPER MINING COMPANY'S SMELTER, KENNET, SHASTA COUNTY.

adjoins the Balaklala on the north and the Shasta King on the west. Between 2000 and 3000 feet of development has been done in tunnels. In four of these tunnels low-grade ore was exposed near the surface. The practice of prospecting with diamond drills, owned by the company, is being inaugurated.

Golinsky Group.—A group of fourteen unpatented claims, in section 28, township 34 north, range 5 west, adjoining the Mammoth line on the east, four miles west of Kennet, owned by B. Golinsky, of Kennet. The property was bonded to an eastern exploration company, J. G. Fletcher superintendent, with office in Kennet. A body of sulphides has been disclosed, underlying a mineralized rhyolite, the presence of which was indicated by a gossan outcrop. The ledge has a strike southwest-northeast and dip southeast.

Keystone Group.—Six unpatented claims in section 23, township 33 north, range 6 west; owned by G. Grotefend et al., of Redding. It was under bond to San Francisco people, but was forfeited on account of cessation of work.

The foregoing properties are those worthy of present note (1908) on the west side of the Sacramento River, and embrace the groups of claims ranged for about twelve miles along the western end of the belt northeasterly from Iron Mountain. On the east side of the Sacramento River the belt includes the following properties:

Gregory & Whalen.—Also known as the Oom Paul group. Undeveloped claims showing gossan croppings 30 to 40 feet wide, situated on the Sacramento River, a few miles north of Kennet, in section 25, township 35 north, range 5 west.

Shasta May Blossom Group.—Known as the Keith group. This property comprises twenty-two unpatented claims in section 14, township 34 north, range 3 west. The present development consists of seven tunnels, aggregating 2000 feet, besides some 15 or 20 open cuts. The lower or main working tunnel is in about 700 feet, and crosscuts what is believed to be the ore body. The vein matter is a spar and the foot wall is a gray schistose rock, while the hanging wall is a granite-

AFTERTHOUGHT SMELTER AT INGOT, SHASTA COUNTY.

porphyry. The next higher tunnel starts on the west side of the mountain, on the lower end of the Copper King claim, running 430 feet to the northwest through the wall rock. This tunnel encounters a widening of the ore bearing formation. The ore is decomposed and carries some gold. Higher up the hillside there is a body of gossan croppings, probably 30 feet wide. The top of the mountain is capped with rhyolite; below it and dipping to the east, are the gossans. The company is operating a compressor driven by two gas engines, but hand drilling is also employed. This property is owned by the Shasta May Blossom Copper Company. President, M. Lindley, of Fruitvale, Cal.; superintendent, L. S. Smith.

Brushy Canyon Group.—A number of unpatented claims in section 34, township 34 north, range 3 west; developed under bond by F. H. Dakin & Co., Studio building, Oakland, Cal.; owned by W. Collins, M. Barker et al., of Copper City. A tunnel is in over 300 feet through a black, slaty-shale formation, distorted and sheared by intrusions. The ledge outcrops on the surface.

Doedollis Group.—Consists of five unpatented claims located in section 34, township 34 north, range 3 west, and is owned by William Ellis, J. L. Cannon, and others.

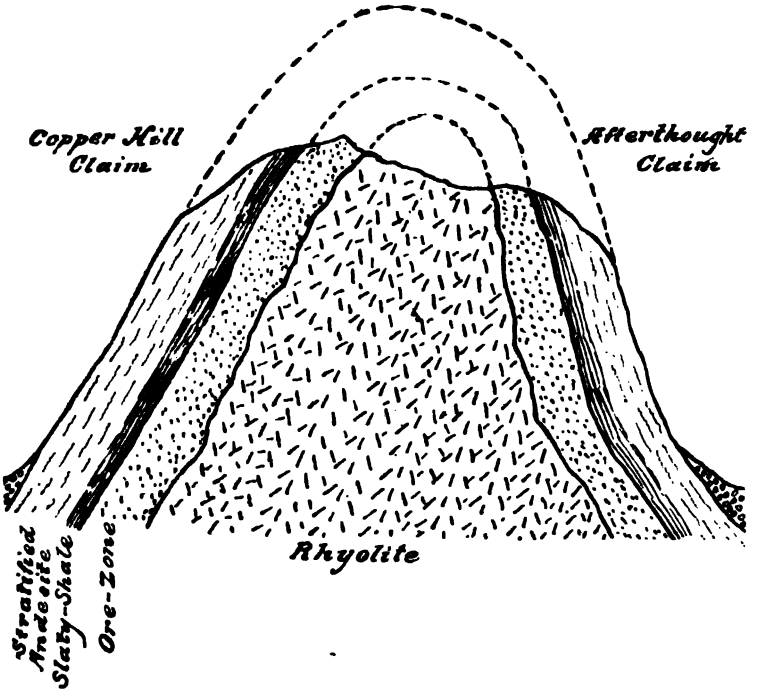
Afterthought Mine.—The property of the Great Western Gold Company, is situated at Ingot, in sections 10 and 11, township 33 north, range 2 west, and consists of twenty claims, ten of which are patented. The town of Ingot spreads along the west side of the canyon of North Cow Creek, which runs into the Sacramento River; elevation 1150 feet; twenty-four miles from Redding, the county seat. Though this company is known as the Great Western Gold Company, its values consist principally of copper and silver, with an appreciable amount of gold. Of the claims, the Copper Hill and the Afterthought hold the larger part of the ore body and are the main producers. The ore body is distinctly a contact deposit in a formation of marked schistose character, which is indicatory of severe metamorphic action. Evidences of great movement are more noticeable near and in the contact zone, a condition which was doubtless inaugurated at the time of the rhyolitic and basaltic intrusions. Where metamorphic action has caused

greatest movement in shales and stratified andesite, richest ores are encountered. The contact is followed to a considerable depth, much of the best grade ore being mined from the lower levels. The ledge has a northwest-southeast strike and dips steeply to northeast. Development work in the Afterthought has been greatly increased and systematized under the present management. The main working or adit tunnel extends 3000 feet into the hill, intercepting the shaft which is 330 feet above this level and 194 feet below it, and is still being sunk.

All stopes and levels are connected with shoots and upraises, so that gravity trams the ore from the various levels to bins on the tunnel level. In stoping the square set timbering system is employed, the timbers for which are furnished by the Terry Lumber Company, whose famous 30-mile V-flume passes directly in front of the mine. The depth of the shaft is 545 feet, the aggregate tunnel development reaches 2555 feet, and the total of the drifts is 4000 feet, a summary which does not include several upraises, winzes and crosscuts. All of this work, with that in the smelter, is yielding employment to 200 men. The ore is extremely refractory, containing in its mineral content high percentages of zinc and barium. Gold and silver in the content greatly enhance the commercial value of the ore, but at present no attempt is made to recover the zinc occurring as the sulphide (sphalerite). Copper sulphurets are essentially in the form of peacock ore, or bornite, and copper-pyrite, or chalcopyrite. The ore is sufficiently silicious to eliminate the necessity of smelting any barren material with the exception of limestone, and this quantity is minimized by lime in the ore. The lime rock is transported two and a half miles by team, stored in large bins on the sidehill near the mine, and drawn off into ore cars as it is needed at the smelter.

Immense bodies of the ore are so heavy in zinc that the company is installing a hand-picking belt with an idea of picking out the zinc and waste. This will produce two very important economic results, namely, the recovery of the zinc, which has heretofore been lost in volatilization, and a material reduction in the refractoriness of the ore, thereby lessening the percentage of coke in the charge as well as minimizing the tendency of the furnaces to freeze. This class of ore will first pass through a 1-inch revolving bar screen. The coarse or oversize

will then be directly fed to a 15 by 30-inch Blake crusher, and thence on to the belt conveyor discharging into bins above the tracks in the smelter yard. As the belt conveys the ore to the bins the waste will be picked out and discarded, and the zinc will be sorted and stored for shipment or treatment as the company may plan. The ore in the bins, together with



SECTION THROUGH COPPER HILL AND AFTERTHOUGHT CLAIMS, SHASTA COUNTY.*

the fines from the screenings, will be smelted. Of course, this method of treatment may be varied somewhat to comply with the varying character of the ore. Connecting the main working tunnel of the mine and the smelter, about one mile apart, is a 30-inch gauge railroad, equipped with Davenport steam locomotives. Each train of about 12 cars represents a lot of homogeneous ore. Lots of different character are dumped at the smelter from high trestles in layers so as to make a mixture ready for smelting, thus approximating the bedding system.

* By J. Kruttschnitt, Jr.

Ore from the bins, following the crushing and zinc sorting treatment, will be dumped in layers on the same mixture. However, previous to dumping at the smelter yard, each car in a lot of ore is carefully sampled, and twice a month, or oftener, each lot is run through a well-equipped sampling mill (adjoining the smelter) and subsequently assayed. One 30-horsepower motor drives one crusher, two sets of rolls, two automatic samplers, and one sample grinder, which constitute a sampling equipment capable of accurate and efficient results. The smelter, as the illustration shows, is situated near Cow Creek, with the hills rising steeply in the rear. Up this incline the flue is led to the tall stack. One 42 by 150-inch water-jacketed blast furnace having a capacity of 250 tons burden is in constant operation. Next to this is the old, or original, 40 by 96-inch furnace.

The power house for the smelter involves the use of three motors aggregating 265 horsepower, which drive a No. 5 Connersville blower, a No. 6 Green blower, and a No. 8 Connersville blower. The installation of the last mentioned blower increases the blower capacity sufficiently to readily respond to the demand of an additional 42 by 180-inch blast furnace having a capacity of over 300 tons burden; at present the matte is teamed to Bella Vista, a distance of about twelve miles, where it is then shipped by rail to the United States Smelting and Refining Company, at Salt Lake City. Here it is converted into blister copper. The mine and smelter are operated and lighted by the electricity furnished by the Northern California Power Company. This company operates several generating stations and transmission lines, two of which are connected with the Afterthought mine and smelter. This insures constant service at all times. A difference of potential on the main line of 22,000 volts is stepped down to 2200 and 450 at the transformer station. The initial voltage has recently been increased by the Northern California Power Company to 35,000 volts. A water tank, capacity of 40,000 gallons, in conjunction with an electrically operated pump for constant duty and alternate steam pump, is maintained for fire exigencies.

Donkey Mine.—The Donkey mine, consisting of two patented claims, located in section 11, township 33 north, range

2 west, is the property of the Western Zinc Mining Company, of San Francisco, with offices in the French-American Bank. Mr. C. D. Maze is the company's manager. In addition to this property the company owns the Silverado mine, at Orange, fifty miles from Los Angeles. It is reported that the ores of these two properties are very similar in character and composition. The Donkey mine is an old one, but has lain dormant during the majority of its existence. The Western Zinc Company acquired control of these claims, unwatered the workings, retimbered the shaft and prepared to develop extensively. Electric power can be readily secured from the 22,000 volts transmission line of the Northern California Power Company, which is within a few hundred yards from the shaft. The depth of this shaft is 200 feet, and a drift of 125 feet extends towards the ledge. The ore is rather of complex composition, carrying copper, gold, silver, lead, and zinc in appreciable quantities. The ore is treated at the Reynolds Chemical Works, also property of the Western Zinc Company, and located at South San Francisco. The capacity of the reduction works is 15 tons per day. Here the zinc is reduced as a chloride and the other metals are then recovered. Copper sulphides form by far the greatest bulk of the mineral contents of the ore. Arrangements are under way to ship 12 to 15 tons of assorted ore by teams to Bella Vista, whence it will be transported by rail to the Reynolds Chemical Reduction Works. This ore body is but one and a half miles from the Afterthought mine, and the character and general trend of the deposits, together with the nature of the enclosing country formations, are indications that the Donkey mine is probably located on an extension of the Afterthought ledge.

The Rising Star Mine of the Bully Hill Copper Mining and Smelting Company, acquired between 1900 and 1901, was originally the Baxter-Winthrop group in sections 21 and 28, about 1600 feet from the shaft of the Bully Hill mine. An 18-inch tram connects this part of the property with the smelter. Large, high-grade ore bodies are being exposed by development work, which is systematically pursued throughout the mine. The Rising Star, it is reported, approximates 100,000 tons of proved ore of a massive sulphide character, with the further extent of the ore bodies yet to be fully deter-

mined. The deposits of this mine differ from those of the Bully Hill mine in that they are very irregular in outline, a condition likely due to the zones of cross-shearing which are extremely pronounced through the workings. A considerable amount of water carrying the soluble salts of copper issues from the main tunnel. This solution is led to a system of parallel inclined launders, laden with old pipe and bar scrap iron arranged riffle fashion, the agitating effect thereby produced having noticeably hastened complete precipitation. At the end of these launders are settling tanks which catch the slimes, aggregating some 1300 pounds per month, and assaying from 35 per cent to 50 per cent copper. A new head frame has just been completed over the three compartment shaft connecting the lower levels. Here a double drum electric hoist is installed. A wide, high tunnel with a ½ per cent grade is being driven into the hill to connect the shaft 250 feet below the surface.

The Copper City Mine of the Bully Hill Copper Mining and Smelting Company consists of four claims, and was formerly the Copper City group, comprising the Excelsior, Brown, Humboldt, and Baxter claims. Here development work is being carried on along the same lines as the Bully Hill and Rising Star mines with equally satisfying results. The ores of this mine are high grade, carrying gold and silver values and high percentages of zinc in parts. Though the mineral exposition is extensive and high grade, the mine is a comparatively shallow one, and it is more than reasonable to suppose that the ore bodies now extending upward will be found, on sinking, to gain depth with similar consistency. The standard gauge railroad to Pitt passes directly through this property.

Schmidt's Claim.—One claim near the Kosk Creek group; owned by Charles Schmidt. Some work has been done, showing sulphide ore. The vein is said to be 10 feet in width.

Chattadown Group.—Consists of an uncertain number of claims situated near the headwaters of Chattadown Creek, some twenty miles north of Baird, east of the McCloud River; owned by Edward Sweeney, Reed Bemis, and others. Some showing of gossan on surface and some work done showing sulphides, etc.

Kosk Creek Group.—Consists of twelve claims situated in section 23, township 37 north, range 1 west, a number of miles north of the copper belt; owned by William M. Murray, R. M. Saeltzer, and others. Bonded by W. G. Scott and associates of San Francisco. This group is especially interesting, from the fact that the ore is a dark basaltic rock carrying native copper. The copper occurs in globules and films in the joints and vesicles of the rock. The ore is said to carry some gold. The zone of rock carrying copper is said to have a width of 200 feet. Native metal occurs only near the surface; with greater depth, sulphides are found.

Hartford Group.—Consists of ten claims three miles north of the mouth of Protem Creek, Shasta County; owned by the Hartford Consolidated Mining Company, Wm. Geary president and J. B. Giffen secretary. More than 400 feet of tunnels have been completed, proving some good sulphide ore, but at present only in limited quantity. The lode is said to have a width of 8 feet or more, and to appear along the surface for a distance of more than 100 feet. The surface ores are oxides and carbonates.

Cowboy Group.—Consists of three claims in section 4, township 33 north, range 2 west; owned by H. A. Cook et al., San Francisco. This property has good surface indications. Over 200 feet of tunnels have been completed, and good sulphide ore has been found. The property includes, in addition to the claims above mentioned, 160 acres of land in section 9 of the same township.

Black Diamond Group.—The Black Diamond group, consisting of a half section of land and eighteen claims located in sections 2 and 3, township 33 north, range 4 west, in the Stillwater mining district, is the property of the Northern California Investment Company. A great deal of development work has been done, but the ground is as yet in a practically undeveloped condition. A body of ore of a reported value of 8 per cent copper was encountered. In addition to the Black Diamond holdings, the company holds between 4000 and 5000 acres of patented land located in the Bully Hill region and in the district to the southeast. George Bayha, the vice-president of the company, is in charge of the property.

Roseman Group.—The Roseman group consists of nine claims and a smelter site, located in section 3, township 33 north, and section 34, township 34 north, range 4 west. The ore is a carbonate and oxide near the surface, changing to sulphide with depth. The formation has nothing in common with either the West Side district or that of Bully Hill. The ore occurs in or near the lime deposit, the foot wall apparently being in serpentine. The development is mainly along the outcrop and the greatest depth on the vein attains about 60 feet. The main crosscut from the foot wall toward the hanging wall is in 55 feet. At another point a 40-foot crosscut has been driven toward the hanging wall, but neither opening has disclosed the vein as yet. The vein matter through which these openings extend is well mineralized. In the aggregate 700 feet of tunnel and 200 feet of shafts and winzes constitute the development work. A lower crosscut has been started which will provide 400 feet of depth. The objective point is 600 feet in, and of this 120 feet has been completed. H. Roseman et al., of Redding, owners.

Jaegel.—Consists of seven claims in section 3, township 33 north, range 4 west; owned by Joseph Jaegel.

Memorial.—Eleven claims of unpatented ground in sections 15 and 22, township 33 north, range 4 west; owned chiefly by H. M. LeBaron and others, of Redding. Some sulphide ore has been found.

Michigan Group.—The Michigan group of mines, consisting of six claims adjoining the Recorder claim of the McClure group on the south and west and De La Mar's property on the west, was acquired by the Mount Shasta Gold Mines Corporation, and will be developed with the McClure group. This ground is located mainly on the south and west slopes of Bully Hill and is crossed by one of the Bully Hill lodes. The principal outcrop of the Bully Hill lodes is on the common end line of the Recorder and the Ydalpom claims, the latter being one of the claims that form the Michigan group. The development work consists chiefly of tunnels and drifts. Some very high-grade ore has been encountered in the workings. A shaft sunk on the North Star claim disclosed some very good sulphide ore. The Mount Shasta Gold Mines Corporation acquired an option

on 80 acres of land adjoining the Bully Hill smelter site, which will probably be used as a site for the proposed reduction works in the Bully Hill district. W. F. Russell is in charge of developments.

Northern Light.—One claim, unpatented, in section 21, township 34 north, range 3 west; owned by the Bully Hill Company. Considerable development work has been done on this ground, and good bodies of sulphide ores similar in character to other deposits in this district have been discovered.

Excelsior.—A group of five claims, two of which are patented, located in sections 21 and 28, township 34 north, range 3 west; owned by the Bully Hill Gold Mining and Smelting Company. A considerable force of men was employed in development work upon the Excelsior, South Killinger, and Baxter claims, including what are known as the Baxter and Winthrop tunnels. The lowest tunnel is the Winthrop, which has been driven for a distance of 850 feet, and it is expected that it will crosscut the Baxter-Excelsior ore bodies. In the Excelsior tunnels a body of solid sulphide ore has been exposed more than 20 feet in thickness, but probably high in its percentage of zinc.

Arps Group.—It consists of fifteen unpatented claims owned by R. M. Saeltzer, William Arps, T. Jaegel, and J. A. Keeney, of Redding. W. Arps, after whom the group was named, is in charge of the property at Copper City, which is located in sections 20 and 21, township 34 north, range 4 west, adjoining the Copper City mine of the Bully Hill Copper Mining and Smelting Company. Five or six tunnels have been driven, directed largely to surface exploration, though they yielded a shipment of ore running high in values. The property is being developed under bond by W. E. Casson, of Nevada.

McClure, or Pioneer, Group.—This property is located principally in section 16, township 34 north, range 3 west, and adjoins the De La Mar mine on the northeast. It includes a quarter section of patented land and six claims. The most important claim, the Recorder, lies on Bully Hill immediately adjoining the De La Mar holdings, and is on the strike of the De La Mar lode. The development work on several levels

of De La Mar's Bully Hill mines has been carried practically to the Recorder claim. The principal development work on the Recorder claim consists of a crosscut tunnel, which was started by the pioneer owner of the property, H. C. McClure, and this tunnel has been continued by the Mount Shasta Gold Mines Corporation, which is now developing the mine. Ore has been reached in this tunnel. The ore, like that of its famous neighbor, is high grade and carries good values in gold, silver, and copper. Where the outcrop crosses the McClure ground, recent explorations have disclosed a lode of great width.

Ydalpom.—Consists of two unpatented claims in section 16, township 34 north, range 3 west; owned by T. M. Popejoy and others of Copper City.

INGOT.

Polkinghorn Claims.—Five claims pending patent, owned by the Polkinghorn Mining Company, with post office address at Ingot. R. Polkinghorn is superintending the development of this property. A shaft is being sunk on the croppings. This property is located in section 11, township 33 north, range 2 west.

Canyon Group.—Four unpatented claims in section 2, township 33 north, range 2 west; owned by H. A. Cook and M. Osborn, of Ingot. A 70-foot prospect tunnel has been run under gossan croppings, a little copper pyrite being encountered.

Congress Group.—Six unpatented claims in section 4, township 33 north, range 2 west; H. A. Cook and brothers, of Ingot, are owners. A series of exploration tunnels aggregating 430 feet have been run, but no great depth below croppings has yet been reached.

Gold Belt Group.—Six claims pending patent, in section 4, township 33 north, range 2 west, belonging to J. H. Jones and A. H. Tucker, of Ingot. A shaft down 30 feet penetrated about 6 feet of iron capping, below which a schistose and slaty formation was encountered carrying copper sulphurets with traces of zinc, gold, and silver.

Sanders Group.—Five unpatented claims in section 21, township 34 north, range 4 west; owned by William Arps, R. M. Saeltzer, and others of Redding. This property adjoins the Rising Star mine of the Bully Hill Copper Mining and Smelting Company, and was under bond to a Nevada company headed by W. E. Casson. Tunnels of a prospective nature have been run near the surface. Sinking to encounter ore at depth has been planned.

Slaughter Group.—Four unpatented claims in section 26, township 34 north, range 3 west; owned by George T. Slaughter, of Delmar. A 70-foot tunnel was run into side of hill to tap ledge, which apexes about 30 feet wide, with a northeast-southwest strike.

Horse Mountain Group.—Nine unpatented claims owned by W. Fluke and Carl Jens, of Copper City. This property is situated near the crest of Horse Mountain, in section 18, township 34 north, range 3 west. Assessment work alone has been done. A very interesting deposit of native copper disseminated through a meta-rhyolite is exposed on the surface.

Bismarck Group.—Located in section 3, township 33 north, range 4 west, and consists of six unpatented claims; owned by Joseph Jaegel, of Grey Rocks. A number of tunnels have been driven and some shafts sunk in developing this property. Small amounts of copper sulphides have been disclosed.

American Girl Group.—A group of three unpatented claims in section 34, township 33 north, range 4 west, belonging to W. Fluke, Ira P. Engle, James Doyle, and Alec Hansen, of Copper City. The mineralized formation outcrops, and is reported to yield a very favorable assay for copper. The property is about four miles west of Copper City.

Senator Group.—Located in section 2, township 33 north, range 4 west, about five miles from Copper City on Pitt River, is this group of fourteen unpatented claims; owned and developed by the Combination Gold and Copper Company of Nevada. James T. Davis, of Carson City, is the company's managing director; 450 feet of tunnels represent development work on this property.

Sulphide Group.—Four unpatented claims belonging to J. F. Conkling, of Whiskeytown. This property, about half a mile from the town, is in section 16, township 32 north, range 6 west. A shallow exploration tunnel run along a contact shows up low-grade sulphides carrying gold.

Reno Group.—Fourteen unpatented claims; owned by R. M. Saeltzer, William Arps, J. Jaegel, and J. A. Keeney, of Redding, and situated in section 20, township 34 north, range 4 west. Some shafts and tunnels have been run as assessment work. A little copper ore uncovered during this development. William Arps, of Copper City, is in charge of the property.

Crystal Group.—Owned by the Crystal Copper Company; W. S. Tyler, president; J. C. Harrington, vice-president; J. L. Maginnis, secretary and treasurer. This property consists of twenty-three unpatented claims in section 11, township 33 north, range 6 west, adjoining the Balaklala on the north and the Vulcan claims on the west. Development by tunnels aggregates 200 feet. The company expects to explore its locations by the use of diamond drills.

Endless Chain and Missing Link Claims.—Two unpatented claims; owned and being prospected by E. L. Popejoy and James Drannan, of Copper City. The exploration of this property consists of two 30-foot tunnels. The location is about 3 miles west of Copper City, in section 24, township 34 north, range 4 west.

Graham Group.—Nine unpatented claims; owned and worked by B. A. Graham, in section 24, township 34 north, range 4 west. Post office address, Ydalpom or Copper City. A series of prospect tunnels aggregating 240 feet, a shaft 74 feet, and a drift 55 feet indicate what development work has been accomplished. This property was under bond to W. E. Casson, of Nevada.

Oregon Consolidated Copper Mine.—This property is composed of two groups previously known as the United and Queen Copper groups, in sections 13, 14, and 23, township 33 north, range 6 west. The locations are owned and operated by F. L. Scamman, W. R. Follis, and William Candrick, the

latter of whom is in charge of the work. About 1200 feet in tunnels comprise the development work, which is undergoing a steady increase. The mine was under bond to the Baker Consolidated Copper Company, of Detroit, Mich.

Reynolds Claims.—Five unpatented claims in section 10, township 33 north, range 6 west; owned by C. W. Reynolds, of Kennet. This property, newly located, adjoins the Balaklala on the north.

Varsity Group.—Eight unpatented claims in sections 13, 14, and 24, township 34 north, range 5 west; owned by C. T. Dozier and C. F. Dittmar, of Redding and Kennet, respectively. The property is two and a half miles due south of Kennet.

The Copper Crest Group of four claims in township 33 north, range 6 west, is owned by the Federal Exploration Company, No. 370 Bullit building, Philadelphia. It adjoins the Mammoth property, and shows some gossan on which an incline has been started.

About one and a half miles north of Kennet in the copper belt, where it has assumed an eastern course before crossing the Sacramento River, lies the **Shasta Kennet Group,** containing 80 acres, with about 700 feet of workings. The face of the main tunnel, 470 feet long, shows vein matter with some iron and copper sulphides. It belongs to the Shasta May Blossom Copper Company, office No. 410 Kearny street, San Francisco.

The Ingersoll Group consists of fourteen non-patented claims on the south fork of Motion Creek, in township 33 north, range 6 west (railroad section 25), adjoining the Trinity Copper Company's property. Some heavy gossan outcrops are found, and the two tunnels of 180 and 135 feet show considerable iron and copper sulphides. A tunnel of 165 feet has been run on a quartz vein carrying gold and a little copper. Owner, J. N. Sherman, Copley.

The Motion Creek Group on the north fork of Motion Creek, township 33 north, range 6 west, sections 13, 18, 19, and 25, partly railroad land, adjoining the Spread Eagle group, consists of ten non-patented claims, with surface indications similar to the preceding group, and two tunnels.

COAST RANGE DEPOSITS.

The Coast Range of California presents a copper field of very large area, but one that, through lack of exploration, development, and production, is of minor present importance compared with the copper belts of Shasta County and the Sierra Nevada foothills. The Coast Range (properly the Coast Ranges) of California consists of a group, or series, of ranges stretching for over 500 miles southward from Oregon along the coast of the State and having an average width of about forty miles. Topographically the Coast Range is relatively low, is made up of ranges of diverse trend, and it incloses numerous valleys, the most important ones being those in the general region of San Francisco Bay, which are among the famed garden spots of California. Lying near the coast, with the broadest general slope toward the sea, and with a comparatively low elevation (2000 to 6000 feet), the range possesses a mild climate and receives on the direct Pacific watershed a copious rainfall which bestows an abundant water supply and heavy forest growths. The Coast Range merges with the Sierra Nevada in northern California and in the Tehachapi regions at the south.

The copper deposits, as well as those of other economic minerals, are found scattered over the length and breadth of the range. They are much more numerous and generally of larger magnitude north of the Bay of San Francisco, and they are of greatest number and importance in the large northern region comprising Siskiyou, Del Norte, and Trinity counties, which require main attention in connection with the copper, as well as the gold, resources of the Coast Range.

Where the Sacramento Valley wedges its narrow northern end into the broad mountain mass created by the mergence of the Sierra Nevada and Coast Ranges is found the Shasta County copper belt. Because of the individuality of this belt, and its overshadowing importance as a copper producer, Shasta County is in this work set apart from the copper

regions adjoining it on the east, north, and west, though geographically and topographically it belongs with Siskiyou County to the north. All other copper deposits in north-central California are here grouped as of the Coast Range.

To gain a brief general view of this wide northern copper field, we may go northward from the Shasta County copper belt along the Sacramento River canyon and the railroad line to Oregon for thirty miles to the southern boundary of Siskiyou County, finding but few scattered copper occurrences through all this upper portion of Shasta County. Pursuing this course northward, there is encountered in southern Siskiyou County, near the western flank of Mount Shasta, a series of copper deposits ranged along a belt or zone several miles wide, extending for about fifty miles northward to the State boundary along the central line of the county. The majority of the deposits of Siskiyou County noted in this Bulletin are in this belt, in townships 6, 7, and 8 west and 40 to 46 north, but they are most numerous in the south-central portion, within a few miles of Mount Shasta. This belt is just west of the great blanketing lava sheet of northeastern California and about 70 miles from the coast. Practically connecting with the northern end of the belt described is another series of copper deposits stretching for 60 miles or so along the Siskiyou range and Klamath River, which course westward along the State boundary into Del Norte County. This series of deposits constitutes copper belts in only the broadest meaning of the term, being unconnected occurrences geographically arranged in this manner. In these two belts are the chief known copper deposits of Siskiyou County, though copper is found widely scattered in mineral-bearing districts over the western half of the county. To the west of Siskiyou, Del Norte County, in the northwestern corner of the State, presents a promising copper field. The low divide district, about 15 miles northeast of Crescent City on the coast, and near the State line, is the best known district, and one in which a number of mines were actively worked nearly forty years ago. Other districts in the southern and eastern parts of the county have since become prominent for their copper prospects.

The region comprising these two counties, over which

copper belts or districts, and sporadic occurrences, are thus scattered, is, roughly, over 100 miles long and 50 to 60 miles wide. Viewing the principal deposits of the Coast Range farther southward they may be conceived as forming the stem of a great, rude letter T. They lead southward from southeastern Del Norte and southwestern Siskiyou along a belt nearly 100 miles long, which follows the boundary line between Humboldt and Trinity counties, through the heart of the range and its remote wilderness. A few groups of deposits are found in eastern Humboldt County, but they mainly lie in the two tiers of townships which stretch the length of western Trinity County. The outlines of this big letter T, with a bar 50 by 100 miles in size, and with a stem 100 miles long and perhaps 20 miles wide, may, to aid memory and understanding, be regarded as practically inclosing the copper deposits of the northern portion of the Coast Range and the important copper field of the coast region. The Shasta County copper belt lies about 50 miles east of the center of the stem and directly south of the easterly end of the bar.

This cupriferous T lies in an undeveloped mineral empire rich in gold, filled with mountain streams and untouched forests, and before it is opening a great future, in which the mining industry will hold the leading place. Access to these stores of copper is gained from the railroad to the east, or from the two harbors of Eureka and Crescent City to the west, but from neither side do railways yet reach into these rugged and forested fastnesses, and main highways are few. Only mountain trails lead into some of the regions where copper claims are held and slowly opened at the surface. Plans for a railroad from Eureka across Trinity County to Redding and on to eastern connections have been considered. The Coast Range runs northward into Oregon, and the copper region described also extends into the southwestern part of that state.

The portion of the Coast Range thus described differs geologically from the rest of the range to the southward, and so, to a considerable degree, do the copper deposits. Here, as to the south, the ore bodies occur in veins in igneous or metamorphic formations. In both regions serpentine and diorite

are the characteristic inclosing rocks, and the former especially accompanies them, forming one or both walls. Only in Del Norte County has there been more than superficial prospecting of any of the deposits of this northern region. Quite a number of mines in this county shipped ore in the first half of the decade of the sixties, and at least two were opened to depths of about 400 feet. These developments showed the ore bodies, which were frequently rich, to be irregular bunches of limited extent, as a rule, and not in well-defined lodes. Surface indications and the slight developments that have been made in Siskiyou, Trinity, and eastern Humboldt make it probable that there the deposits will be found more regular and persistent. Wide gossan croppings can, in places, be followed for several miles, but prospect tunnels have yet been run under these croppings in but relatively few cases. The ensuing notes on some of these prospects show that in Siskiyou County and elsewhere tunnels have reached ore bodies from a few feet to forty or more feet wide and carrying good values in copper, with varying percentages in the precious metals. One undeveloped prospect in the remote southwestern corner of Trinity County has become noted for the immense bowlders of sulphide ore, carrying gold, silver, and copper, which have come from an outcropping deposit, one of these bowlders being 60 feet across the base and consisting of several thousand tons of solid ore. Large and valuable deposits will undoubtedly be developed in the future. The copper ores of these northern counties are practically all sulphides. Surface oxides and carbonates do not occur as frequently and extensively as throughout the rest of the range to the southward.

Southward from Trinity County for about 150 miles to the bay of San Francisco, copper deposits are heterogeneously scattered over the ranges through the western ends of Tehama, Glenn, and Colusa counties, through Mendocino and Lake counties to the west, and through portions of Sonoma, Napa, and Marin counties just north of the bay. The majority of the deposits through this large region are associated with serpentine formations, and the prevalent ores are oxides and carbonates. The ores are generally in pockets, and carry but slight values in gold and silver. Native copper occurs as float in

several districts, but assumes no practical importance. The only copper belt presented by this large portion of the range is one 60 miles long, running along the eastern slope, near the range summit, from Tehama County southward through Glenn and Colusa to a termination in Lake County. This is a mineralized zone, along which copper deposits have been discovered at intervals, and many have been superficially opened by shafts and tunnels. One of the small early attempts at copper smelting was made on this belt, and a few tons of ore have been shipped; but, as elsewhere through this portion of the range, no copper deposits of much importance have been discovered and no successful mining has ever been carried on. West and south of this belt are many sporadic occurrences in the counties named, and a considerable number have been prospected to a limited extent at various times, chiefly during the copper excitement of the early sixties and within the past two or three years. The deposits of this portion of the range are more advantageously situated in respect to convenience of access than those of the north. Copper mining in these counties has amounted to little more than gophering after stringers and pockets of ore, often rich in quality, but small in quantity.

For a distance of about 200 miles southward from the region of San Francisco to San Luis Obispo County, copper minerals have been noted in every county of the range, but the occurrences are sparse and of slight significance. In the region of Mount Diablo, in Contra Costa County, many thousands of dollars were spent between 1860 and 1866, by several companies, in prospecting for copper, of which there were surface indications in the form of float, but no deposits were ever found in place. Close to Oakland, in Alameda County, a lode carrying copper and iron pyrites has been mined to supply sulphur for acid manufacture. Many years ago some copper ore was shipped from a deposit in San Benito County. The only copper district worthy of particular attention, between San Francisco Bay and the Tehachapi region at the southern end of the Coast Range, is one in San Luis Obispo County. Here is a belt of cupriferous ores extending for perhaps 20 miles through the mountains between the town of San Luis Obispo and the old mission of

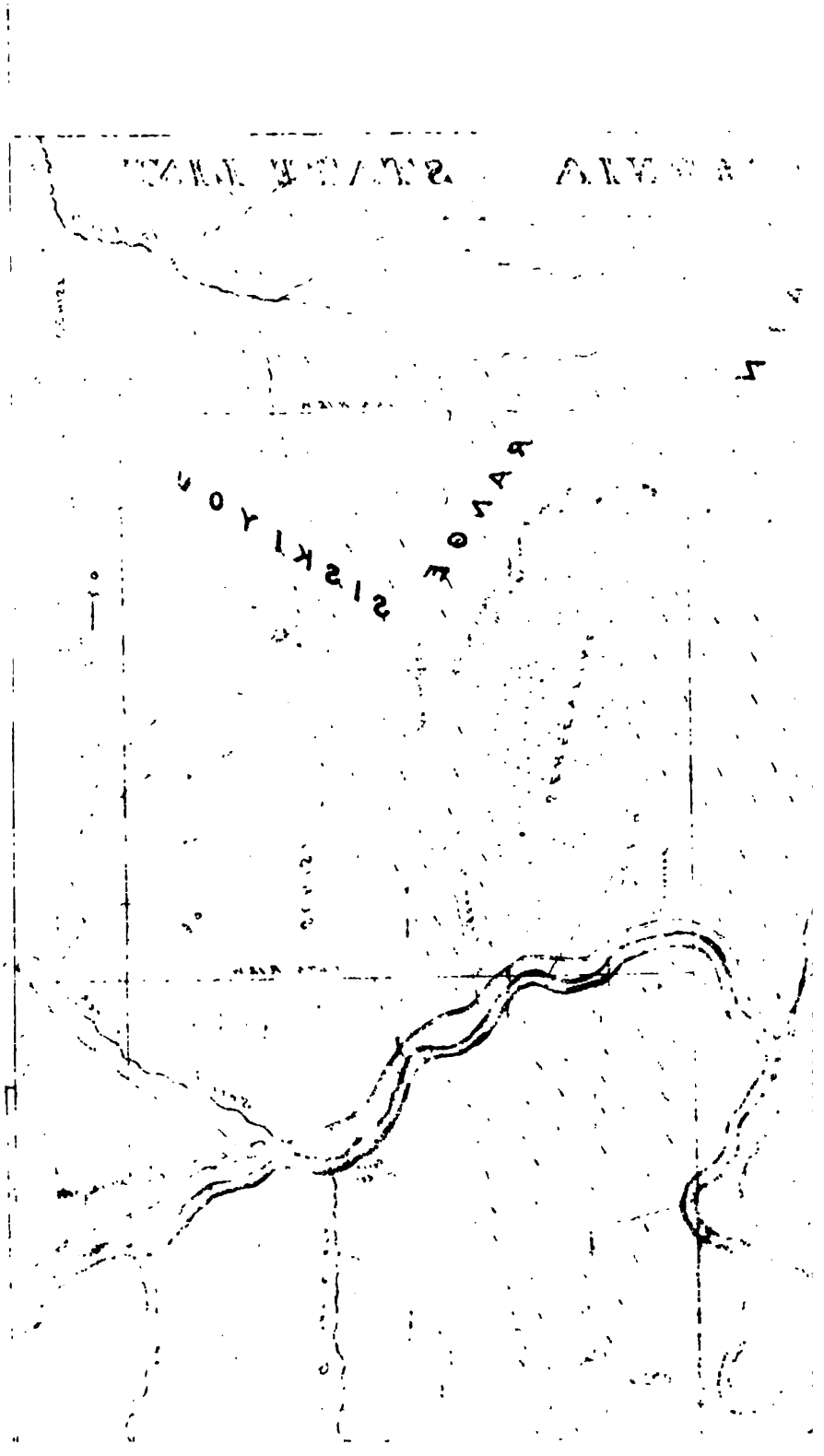
Santa Margarita. During the first period of copper mining in California a great many claims were staked out and considerable ore was shipped from several mines of small development. Recently renewed attention has been given to some of these properties. Near Soledad Pass, in the general region of the mergence of the Coast and Sierra Nevada ranges at the south, there is a copper district which afforded the first copper ores ever mined in California, and which was a lively copper mining camp for a short time in early days.

Throughout the Coast Range there has been no production of copper since the small ore shipments of former times, Many new and old locations have been prospected recently. The northern counties promise important future developments, and throughout the range various properties will probably become small producers in time.

SISKIYOU COUNTY.

Siskiyou County lies along the northern boundary of California, one half the length of which it measures, and has adjoining it Del Norte on the west, Modoc on the east, and Shasta and Trinity counties on the south. Its entire area of 3040 square miles is an exceedingly broken and picturesque expanse of mountains, canyons, and wilderness, threaded by a multitude of streams running southward to the Sacramento and northerly and westerly to the Klamath River, which courses for 70 miles through the county.

The most prominent mountain ranges are the Klamath, Scott, and Salmon. Mount Shasta, in the southern part, raises its whitened volcanic peak 14,380 feet above the sea. The eastern third of the county, comprising thirty-four townships, is blanketed by a portion of the great Sierra Nevada lava sheet, forbidding both mining and agriculture. The rest of the county displays much mineral wealth, mainly concentrated in various belts and districts. There are but two agricultural valleys of importance, the Scott and Shasta, the former 40



miles long by 6 miles wide. There is a multitude of springs, and some important mineral springs are well known.

Its mineral resources constitute the basis of Siskiyou's prosperity and progress. Its auriferous gravels still provide the bulk of the county's gold output, though the period of simple placer mining passed long ago. Along the Klamath and important tributaries large gravel deposits support profitable hydraulic mines and afford abundant opportunities for their multiplication. River-bed mining, by the use of wingdams, has been pursued more extensively than in any other county. Now gold dredging has become firmly established and promises to expand. Here, as in other mining counties, the growth of the mining industry depends on the development of the quartz mines, and in this direction Siskiyou County is now making the greatest progress in its history. Successful gold quartz mines have been developed in the past, notably, the Black Bear with a record of over $2,500,000, but only within three or four years has prospecting for gold ores been general and active and investments of mining capital frequent. This development proceeds rapidly, in spite of the surprising lack of roads and trails to some of the rich but remote mining districts. The Southern Pacific railroad to Oregon crosses the county, with a branch to Yreka. Most of the county is yet public land, and the prospector has a wide and free field. Platinum, chrome, lead, coal, iron, and mineral waters are among the minerals occurring here. This is one of the few counties of the State making an annual mineral record exceeding $1,000,000. Its output in 1900 was $1,010,383, of which $951,397 was in gold.

The copper mines and prospects of Siskiyou County are widely scattered over the central and northern portions of the county, and include some properties of considerable magnitude. Most of them are of comparatively recent development, few of them having found mention in other reports of the State Mineralogist. In the central portions of the county the prospects are confined to a very few townships lying to the east of Scott Valley, in the vicinity of Fort Jones and on certain tributaries of the East Fork of Scott River. The formations in which these deposits occur are either peridotite or gabbro, or a metamorphic schist overlying these eruptives.

The ores are largely sulphides of iron and copper, and include pyrite, pyrrhotite, and chalcopyrite. Some of the deposits that have been regarded as valuable for copper are chiefly interesting for their gold and silver values, and as a possible source of silicious ores for prospective operations.

The prospects found to the north of the Klamath River are scattered throughout the whole extent of the Siskiyou range from the vicinity of the Cottonwood Valley westward to Preston Peak. They may be grouped in five districts—the Cottonwood, Applegate, Indian Creek, Clear Creek, and Preston Peak districts.

The formations in which these deposits occur are various. The Siskiyou range, like other east-and-west ranges in the Klamath region, is one of complex geological structure. In general terms it is composed largely of crystalline schists and slates and basic eruptive rocks which are involved in or underlie them. The basic rocks are mainly of the peridotite-diorite class. Granite also occurs at intervals throughout the range.

The basic crystalline (eruptive) rocks form some of the most prominent points of the range, no less conspicuous for their color than for their altitude. Several of the prominent mountains have been indiscriminately styled "Red Mountain," on account of the reddish-brown color which peridotite assumes in weathering. Preston Peak, Greyback, and others of the higher summits are of diorite or kindred rocks. While the main course of the range is westerly, its actual watershed is extremely devious, passing alternately into Oregon and into northern California. Copper deposits are found either in slate, schist, diorite, gabbro, or serpentine.

The Siskiyou Mountain copper belt, if it may be so styled, follows approximately the Oregon and California state line for a distance of 60 miles, with a width of more than 20 miles from the Klamath River north into Oregon. As a mining region it has been prospected to a very small extent for either gold or copper. Yet it is interesting to remember that the streams heading in this range, both on the north and south, have been among the richest placer streams in this region. And it is also true that this range contains as clear evidences of copper deposits as of gold, and should be as attractive to prospectors in search of base metals as to those in search of

any other. Although this region is exceptionally rugged in places, it is by no means unapproachable, particularly from the north. The natural advantages of water-power and timber are everywhere abundant.

The following groups of copper claims are those of most note that are known in Siskiyou County:

Hummer Group.—Consists of three claims in section 18, township 40 north, range 7 west, Mount Diablo meridian; owned by Messrs. Mischler & Rollins, of Callahans. These claims have been worked to only a limited extent by shafts and open cuts. The formation is mainly serpentine, though the ore deposits are connected with dikes of quartz porphyry which have penetrated the serpentine. The ore lies in irregular bodies, consisting of pyrrhotite and other sulphides carrying copper. The ore is said to contain nickel.

Bonanza Group.—Twelve claims in one body situated in sections 27 and 34, township 42 north, range 8 west; owned by Charles S. Cowan, of Fort Jones, W. S. Carrico, and others. Developed by shafts and tunnels. These deposits are in the form of quartz veins carrying a small percentage of sulphides, but are chiefly interesting for their gold and silver values.

Copper Queen Claim.—One claim in section 27, township 46 north, range 9 west; owned by H. J. Barton, of Oak Bar, and William Moxey; developed by tunnels 300 feet in length. The deposit is a quartz vein carrying sulphurets of iron and copper.

Plutus Group.—Five claims situated in sections 12 and 14, township 40 north, range 8 west; owned by McCarter and John Erickson, of Callahans. The ore is pyrrhotite, with a small percentage of copper. The formation is gabbro and serpentine.

Fortuna Group.—Two claims in section 14, township 40 north, range 8 west; owned by E. G. Harrison of Callahans, and others. The ore is pyrrhotite, etc., in gabbro and diorite.

Solomon.—One claim in section 14, township 40 north, range 8 west; owned by M. Greenberg of San Francisco, and developed by one shaft.

Hidden Treasure.—Three claims, located on Boulder Creek, four miles southwest of Callahans; owned by John Russel and the Alger Brothers of Callahans. The vein is said to have a width of 8 feet, consisting of sulphide with some quartz. It carries copper, with some gold and silver. On the property there is one tunnel.

August Flower Group.—Two claims in section 1, township 41 north, range 8 west; owned by Harrison Bros., of Callahans. The ore consists of irregular bodies of pyrrhotite and chalcopyrite in serpentine.

Huntley Claim.—One claim situated in section 12, township 40 north, range 8 west; owned by Harry Mitchell, William Bremer et al., of Callahans. The ore consists of pyrrhotite and chalcopyrite.

Lytle.—Two claims in section 20, township 40 north, range 7 west; owned by J. A. Lytle & Son, of Callahans. Developed by tunneling. The ore, which consists of irregular bodies of chalcopyrite and pyrrhotite, follows a contact between a dike of quartz poryhyry and serpentine. Some of the lenses of ore have a thickness of 10 to 15 feet. The ore also contains some gold.

Polar Bear Claim.—One claim in section 12, township 40 north, range 8 west; owned by G. Welker & Sons, of Callahans, and others. Developed by a shaft and tunnels. The principal ore body consists of a shoot 5 to 6 feet wide, from which nearly 200 tons of ore were extracted in 1900, carrying values reported at about 17 per cent of copper. The ore is chalcopyrite and pyrrhotite in serpentine.

Rader Group.—Three claims in section 17, township 40 north, range 7 west; owned by Charles Rader, of Gazelle, and others. Some development work has been done. The ore consists of pyrrhotite, and is said to contain nickel.

Turner Claim.—One claim in section 7, township 40 north, range 7 west. Some work has been done, with a good showing of chalcopyrite.

Monarch Copper Group.—Consists of about 240 acres of patented land situated in the east half of section 7, township 40 north, range 7 west; owned by the Monarch Copper Mining

Company, Charles F. Pettey, of Callahans, president. Developed by tunnels and shafts. Sulphide ores of good grade are reported.

Thanksgiving Group.—Consists of several claims one and a half miles northeast of Oro Fino; owned by George Henderson, of Fort Jones. Surface indications very good.

Rothkoph Group.—Fifteen claims located in sections 5, 6, 7, and 8, township 43 north, range 8 west, four miles northeast of Fort Jones; owned by George Henderson, of Fort Jones. Developed by shafts and tunnels. The formations are basic eruptive rocks, including serpentine overlaid by silicious strata containing some slate. The ore lies partly along the contact, and consists of chalcopyrite and pyrite in lenticular bodies, having a width of 5 or 6 feet. Several patches of gossan and iron-stained rock occur on the surface. Some of the ore carries values reported at 12 to 15 per cent copper.

Schnider Claims.—Two claims in section 12, township 40 north, range 8 west, and section 18, township 40 north, range 7 west. Developed by open cuts. The ore is similar to that of the Polar Bear. Owned by L. Schnider & Son, of Callahans.

Rainbow Group.—This property is located in the Mount Eddy district, and consists of 300 acres in section 24, township 40 north, range 5 west, four miles southwest of Sisson. It is owned by the Wood & Sheldon Lumber Company of Sisson. Gossan croppings, 100 to 600 feet wide, are exposed for over a mile on a spur of Mount Eddy, the strike of the vein being 70 degrees west of north, with a steep dip to northeast. The development consists of tunnels, a number of open cuts and shallow shafts along the croppings. The main or east tunnel penetrates the hill for 400 feet, bearing a little east of north, and cutting the vein 300 feet from the mouth. The width of the vein is 6 feet, and the character of the ore is a massive sulphide, similar in appearance to the ores of the copper belt of Shasta County. The foot wall is a soft green stone, and bodies of serpentine and intrusive granite, porphyry and rhyolite occur in the vicinity of the mine. The lumber company's railroad skirts the edge of the mountain on which the property lies. The property has been known for thirty years. It was first worked for gold.

Yellow Butte Mine.—The Yellow Butte consists of 300 acres in the west half of section 25, township 40 north, range 5 west, about fifteen miles from Montague, on the north slope of Mount Shasta. The formations are schist and granite, the vein is enclosed in the latter rock, its strike is north-south, dip 60 degrees west, width 4 to 5 feet. It contains oxides and sulphides of copper in a quartz gangue. Development work consists of drifts and crosscuts and two shafts, the main shaft being sunk on the foot wall. The mine is close to the California Northeastern Railway, which connects with the Southern Pacific road at Weed. Secretary of the Yellow Butte Company is Dr. J. D. Ball, of San Juan; superintendent, L. D. Ball, of Edgewood.

Bonanza Group.—Two claims in township 47 north, range 8 west, Mount Diablo meridian; owned by Erick Carlson, of Hornbrook, and others. The property is developed by tunnels, shafts, etc., showing a deposit of sulphide ore 8 to 12 feet thick, which has been followed laterally for a distance of 100 feet. The ores are pyrrhotite and chalcopyrite, some of which carry a good percentage of copper. Assays have shown reported values ranging from 8 to 20 per cent copper.

Bunnell Group.—Comprises a number of claims situated near the head of Dutch Creek, adjoining the Bonanza group, and containing similar ores. They are owned by the Bunnell Brothers, of Gottville.

Unexpected Group.—Two claims in section 17, township 47 north, range 8 west; owned by Ponnay Brothers et al., of Portland, Oregon. These claims join the Bonanza and Bunnell groups, and contain ores of the same character. They are developed by short tunnels and open cuts.

The deposits of the three preceding groups are mainly contained in a crystalline (hornblendic) schist, associated with peridotite.

Silver Mountain Mine.—Five non-patented claims in section 20, township 40 north, range 7 west; owned by J. A. Lytle, of Callahans. They are situated on Silver Mountain, along Grouse Creek, seven miles northeast of Callahans. Development, tunnels and crosscuts, with several upraises and winzes. Ore occurs in a serpentine schist, faulted and distorted

by intrusions of porphyry. Strike of vein nearly north and south, dip 45 degrees west. Considerable heavy sulphide ore, reported to average from 5 per cent to 6 per cent, is exposed in a well-defined but twisted vein.

Ten Lakes Mine.—This property is owned and operated by the Ten Lakes Mining Company, of Edgewood, Cal. C. S. Osborne is manager. The location consists of nine claims and water rights in section 20, township 4 north, range 6 west. Claims not patented. Development, numerous open cuts. The ore formation is very similar to that of the Yellow Butte mine. The ore consists of carbonate and sulphide in a shattered quartz of vein-like structure enclosed in the porphyritic granite formation. Hornblende takes the place of mica in much of the granite. Elevation, 7000 feet.

Hathaway Mine.—This property comprises the northeast quarter of section 11, township 40 north, range 9 west, situated on Sugar Creek, about four miles from Callahans. There is a well-defined fissure vein with a porphyry foot and a quartz hanging wall, 18 to 24 inches wide; strike northeast-southwest; dip almost vertical, gangue rock quartz. The mine has been worked for gold, but in depth sulphides of copper were encountered. There are several hundred feet of tunnels, stopes, and upraises. Owner, E. Hathaway, of Etna.

Eaton Claims.—Three non-patented claims on Tiger Fork of Sugar Creek, about five miles from Callahans. Oxides and sulphides of copper are exposed on the surface in garnetiferous rock, containing quartz and calcite. Development, tunnels and numerous open cuts. The tunnels show disseminated sulphides in the faces. Owner, Mr. Eaton, of Etna.

Bathhurst Claims.—Patented land, northeast quarter of section 15, township 40 north, range 9 west, on both sides of Sugar Creek, about six miles from Callahans. Owner, E. W. Bathhurst, of Etna.

Driggs Claims.—Three non-patented claims in section 18, township 40 north, range 7 west. Owned by E. H. Driggs, of Berkeley.

ELLIOT MINING DISTRICT.

In the early days of placer mining many of the streams on the northern slope of the Siskiyou Mountains, tributaries of the Rogue River, were worked for gold, and in many places remnants are found of extensive operations. When the placers became exhausted, more attention was paid to lode mining, but no great results were achieved. Many of the veins carried copper, which at that time was a detriment rather than an advantage, and they remained idle if they did not contain sufficient values in gold besides to make the work profitable. With the increased importance of the copper industry, these prospects have attracted considerable attention lately, work has been resumed on the older properties, and many new locations have been made. Elliot district, townships 47 and 48 north, range 12 west, comprises the drainage area of Elliot and Cook and Green creeks, tributaries of Applegate River, from their mouths, about 1500 feet above sea level, to the summit of the range, 6000 feet above sea level. The mountains are formed by crystalline silicious chloritic and micaceous schists, overlying basic igneous rock, showing in the lower valleys. Two miles above the mouth of Elliot Creek, at its junction with Joe Creek, lies the old placer camp and post office, Joe Bar, 1900 feet above sea level, and six miles farther up the latter creek is located the

Blue Ledge Mine, the most important property in this district, owned by the Blue Ledge Mining Company of New York. Considerable improvements have been made on the surface and underground. A good wagon road was built from Joe Bar to the camp, 4000 feet above sea level, which has a sawmill, offices, residences, etc., sufficient to accommodate a large force. The underground workings aggregate over 2500 feet. The ore occurs in a vein bearing north and south, dip almost vertical, with a slight inclination west, its outcrop being traceable for about 3000 feet. The east, or foot wall, is formed by a dark gray or black, somewhat micaceous, schist; the west, or hanging wall, by a soft white hydro-mica schist. The walls are not always well defined, mineralization extending frequently into the hanging wall, but the ore bodies are usually separated by a thin band of clayey matter of brown color. The ore consists

of pyrite, chalcopyrite, and other sulphides and oxides of iron and copper, and carries a small percentage of zinc blende and some quartz. The average value of the ore is reported above 6 per cent of copper and more than $5 per ton of gold and silver, samples giving occasionally much higher assays. The two main tunnels are 250 feet apart, and are connected by winzes and upraises. Both of them show ore, and an intermediate drift runs over 150 feet in a solid body 40 feet wide in places. Besides a fair percentage of copper, the ore is reported to have assayed as high as $100 in gold. It is stated that the company has planned the erection of a smelter on Applegate River and a wire tramway from the mine to the smelter.

The St. Albans Group of fifteen claims, owned by H. Callaghan et al., post office, Eileen, adjoins the Blue Ledge property on the east. The formation is the same as in the former, and iron-stained croppings are found on the surface. Development consists in three tunnels, including drifts, a total of 470 feet.

The Cook and Green Group, four claims, owned by the Siskiyou Copper Company, W. Oxley, Toronto, is located at the head of Cook and Green Creek. Two tunnels have been driven in strong iron gossan on the west side of the creek, one close to the creek, the other about 300 feet above. Both show sulphide of copper with pyrites of iron in the face. On the west side of the creek in the continuation of the same outcrop is one tunnel, and 50 feet below another, the faces of both being in sulphide ores.

Buck & Sullivan have located a claim on the same mountain, running a tunnel.

The Bloomfield, owned by L. Adams, Eileen, has a tunnel on a vein showing some sulphide ores.

The First National Claim, owned by the Joe Creek Company, Medford, has two tunnels, showing some sulphides.

E. L. Jones, of Hutton post office, owns a group of eight claims, extending from Joe to Elliot Creek. A strong gossan crops out on the Copper King and Copperopolis claim, and a

30-foot tunnel with a 90-foot drift has cut a vein of over 5 feet of ore, sulphide of iron and copper, with some quartz and bornite, which is said to assay 9 per cent copper, $8 in gold, and $6 in silver. A tunnel has been started lower down to cut this vein at greater depth and is in 230 feet.

The same party owns the Iglo group of five claims on top of the range, on which development work, tunnel and crosscut, has been done, and which has ore reported to carry $45 in gold and copper values.

E. S. Huff owns ten claims on Elliot Creek close to the Oregon line, on which three iron-stained outcrops can be traced. A tunnel on the north side of the creek is in 50 feet.

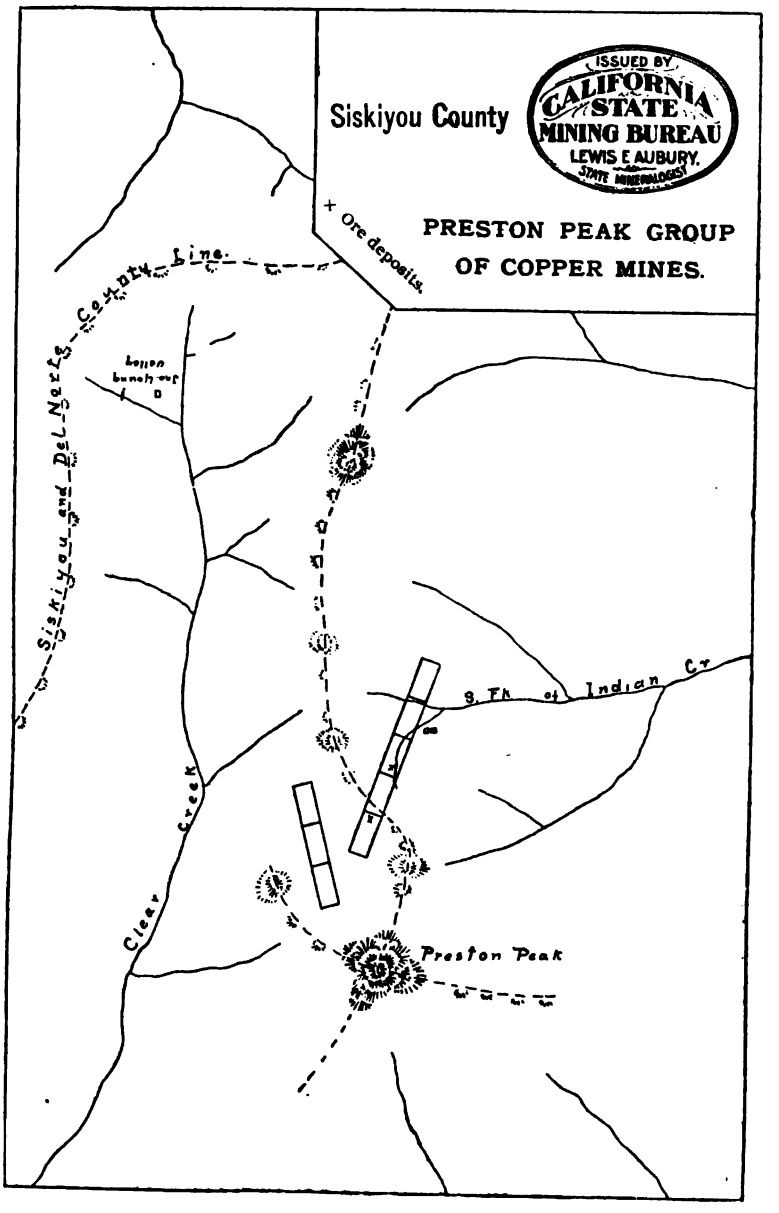
On the southern slope of the range the following locations have been made:

Morris group, nine claims.
Shaco group, two claims.
Selby & McGill, two claims.
Anderson group, four claims.
Wellington, Green & Page, five claims.
Copper City group, twelve claims, Wells & Wetzel.
Little Jimmy group, two claims.
Jonesville group, one claim.

HAPPY CAMP MINING DISTRICT.

Happy Camp is situated on the Klamath River, at the mouth of Indian Creek, in township 29 north, range 8 east, at an elevation of 1092 feet above sea level. Extensive placer mining was carried on in the early days along the river and its tributaries, and hydraulic sluicing is still in operation in many places. In recent times the numerous indications of copper have received some attention, and a number of claims have been located on the mountains overlooking the Klamath, and especially on the ridges on both sides of Indian Creek. These mountains consist of a coarse-grained granite porphyry, underlying talcose schists, dolomite and serpentine.

The Oak Hollow Group, six miles from Happy Camp, above the Klamath, nine claims, unpatented; two tunnels. Pyrites with little copper.


Siskiyou County
ISSUED BY
CALIFORNIA STATE MINING BUREAU
LEWIS E AUBURY.
STATE MINERALOGIST
PRESTON PEAK GROUP
OF COPPER MINES.
+ Ore deposits.
Siskiyou and Del Norte County Line.
Clear Creek
S. Fk of Indian Cr
Preston Peak

The following claims are located in township 27 north, range 8 east:

The Dewey Group.—Five claims; located in 1895 by W. I. Brown; bonded to Frank H. Dakins, Jr., Yreka. A strong vein in schist, course southwest-northeast, dip northwest. Tunnel 100 feet, drift 280 feet, all in ore; chalcopyrite and pyrite; said to assay from $2 to $8 in gold. Width not exactly known. There are three other tunnels besides and one 50-foot raise, or 1550 feet altogether. This property is situated east of Indian Creek, 2760 feet above sea level, seven miles from Happy Camp.

The Gilpin Group.—Five claims, on the same mountain south of the Dewey group. A strong outcrop of gossan and sulphides, running northeast-southwest.

The Doolittle Creek Group of eight claims; located by I. H. Hendricksen, at the head of Doolittle Creek, west of Indian Creek, shows a gossan outcrop and sulphide ore in a 25-foot cut.

The Little Blue Group, two miles above Happy Camp, consists of nine claims, and shows some oxidized and sulphide ores in an open cut. Owners, Wells & Moon, Happy Camp.

Clear Creek District.—A number of claims have been located on Clear Creek and its tributaries, west of Happy Camp. About eight miles above its mouth Dr. F. Tebbs, of Weed, owns and has bonded forty claims on which are large iron outcrops.

The Buster Group of ten claims belong to the same parties.

Buzzard Hill Group.—Nine claims on the east side of the Klamath.

Titus Creek, on the east side of the river, ten claims owned by Dr. Tebbs. Eighty feet iron outcrop. Titus Creek had very rich placers in the early days.

Nigger Creek Group.—Several claims owned by David Jones et al., of Fort Jones, situated near the head of Nigger Creek, five miles northwest of Hamburg Bar.

Preston Peak Group.—Five claims situated at the head of the south fork of Indian Creek, one and a half miles north of Preston Peak; owned by Preston Peak Copper Mining Company. Developed to some extent in past years. The formation

is mainly diorite or gabbro. The lode crosses the summit in a southwesterly direction, and consists of a succession of shoots, some of which have a width of 20 to 30 feet. The ores are pyrite and chalcopyrite. The average grade of the ore is said to be 12 per cent in copper, with some gold. This property is one of the pioneer discoveries of the Siskiyou belt. The main tunnel is 300 feet long, and shows ore all along, chalcopyrite, some bornite, and native copper. One hundred feet from the mouth a winze was sunk 40 feet deep, all in ore, which carries some gold. A tunnel was started some distance below.

DEL NORTE COUNTY.

Del Norte County commands a prominent place in any story of California's copper industry, on account of its historical associations with the beginning of that industry and because of the quite widespread occurrences of copper ores, their frequent richness, and the possibilities of future development.

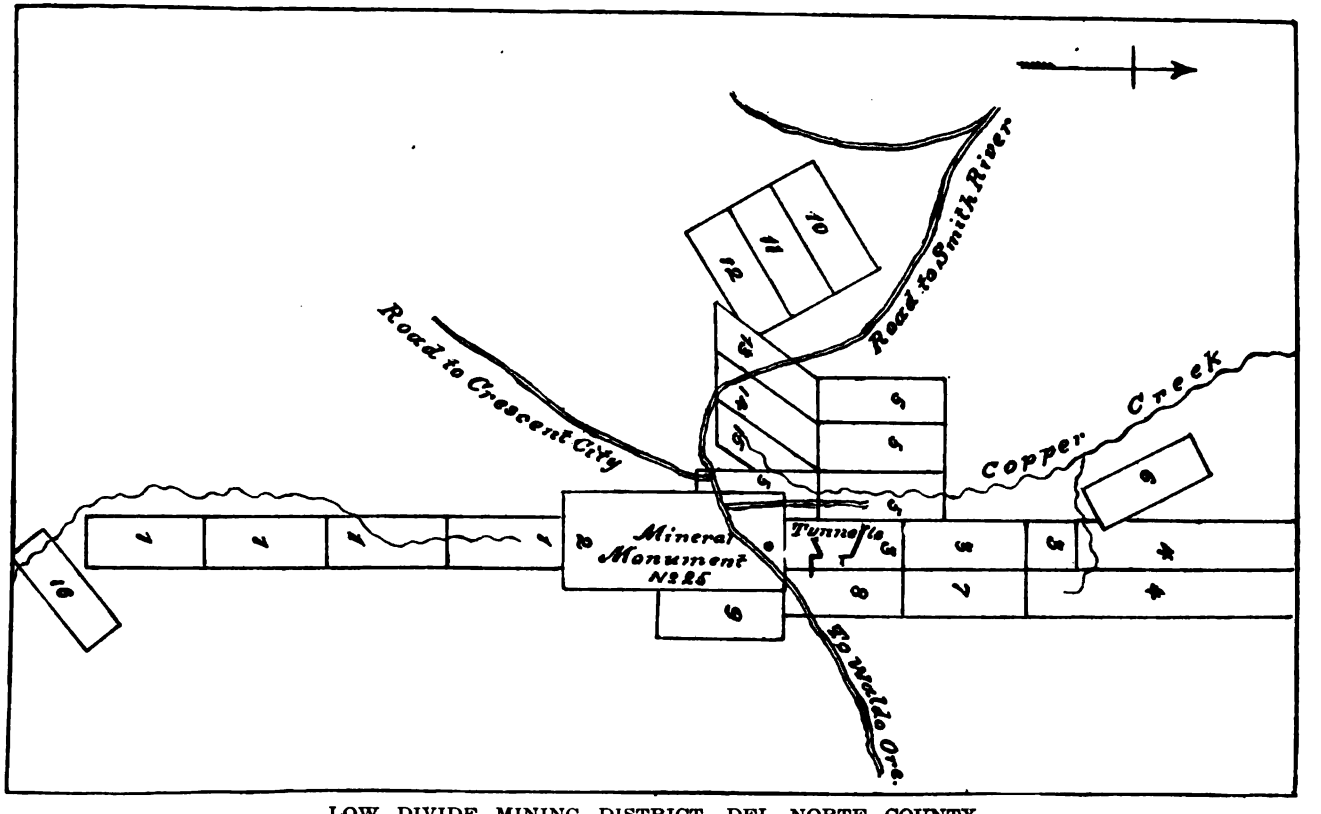
It is one of the smaller counties of the State, is sparsely settled, and possesses well-wooded and mineralized mountains in the seclusion of the northwest corner of the State, far from railroads, and with the Pacific for its chief highway to the rest of the world. It is this remoteness which has been the principal hindrance to the development of its mineral resources, among which copper has ever held an important place. As is noted elsewhere, copper mining was active here in the sixties, and thousands of tons of high-grade ore were shipped to Swansea at a cost of about $30 per ton, including costly haulage to the coast. That unfavorable economic condition, coupled with lower prices for copper and a partial exhaustion of rich surface ores, imposed a long quiescence on the industry. Many favorable conditions for copper mining exist, and sooner or later capital will undertake efficient exploitation by modern methods. The larger part of the county's area is yet public land, and here the prospector finds a continuance of the

wide and attractive field afforded in adjoining counties of northern California.

Most of the known deposits of copper in this county lie along its northern border, and for the most part are situated on some of the northern tributaries of Smith River. Three districts are now generally recognized along this belt, although good deposits occur outside of them in other sections of the county. The two older districts are those of the Low Divide and of Diamond Creek. The more recent discoveries have been made farther east, upon Shelly Creek, and one of the tributaries of the Siskiyou Fork of Smith River. In the southern portion of the county is the Doctor Rock group, which will be mentioned elsewhere.

The formation which composes the greater part of Del Norte County and that in which most of the copper deposits lie is peridotite (serpentine). Diorite or gabbro is generally found accompanying the peridotite, and they are generally regarded as more favorable to permanent deposits of ore. The cores, or central portions, of many of the ridges and spurs are of a gray crystalline rock, either gabbro or diorite. This is superficially covered by a thick casing of serpentine. The diorite or gabbro appears in the more prominent points of the mountain, protruding through the serpentine, or exposed by erosion in some of the deeper canyons. At the contact of the serpentine with the gabbro or diorite, or within the crystalline gray rocks themselves, have been found some of the better deposits of ore, not only in Del Norte County, but also in Siskiyou and Trinity counties.

Most of the copper deposits of this county, however, are either in the peridotite, or are more or less closely connected with it. In many cases the shoots of ore that have been developed in former years are limited in extent, few of them having been proven to contain more than a few hundred, or even a few tons of ore. They are generally irregular, or else consist of a series of bunches or lenses of ore arranged along a zone which is itself only vaguely definable. The ore is often of very high grade, consisting of copper glance, black and red oxides, carbonates, and native copper. Pyrrhotite is often found, and in some cases magnetic iron or chromite accompanies the ores of copper. Chalcopyrite is not common. Gold



LOW DIVIDE MINING DISTRICT, DEL NORTE COUNTY.

and silver are almost universally reported as accompanying the copper and correspondingly increasing its value. It is not unusual for shipments of ore to carry an average of 30 per cent, and often reach 50 to 60 per cent in copper. The cost of shipping ore from Crescent City to San Francisco is approximately $6 per ton. The transportation of ore from the mines to the landing varies in each case, but it has generally ranged between $2.50 and $10 per ton.

The following are some of the more important copper mines and claims in the various districts of Del Norte County.

According to reports only assessment work has been done on Diamond Creek, but a number of prospects are being developed on Patrick and Shelly Creek (Monumental post office) along the stage road from Grant's Pass to Crescent City. Of greater importance, however, is the resumption of work in the Low Divide district, which produced all the ore shipped in former years to Swansea or elsewhere.

THE LOW DIVIDE DISTRICT.

Situated at the head of Copper Creek, a tributary of Rowdy Creek, in the mountains which reach an elevation of 2000 feet above sea level, twenty miles from Crescent City, and nine miles from Smith River, with a fair wagon road from the latter place. The formation consists principally of serpentine, compact and fine grained in the lower parts, coarse grained with bronzite and hornblende in the upper portions, resembling gabbro. On the surface it assumes a gray and granular appearance, owing to the deterioration of the softer minerals in its composition. The main vein follows a ridge on the east side of Copper Creek, course north and south; dip east 45 to 60 degrees; width 4 to 6 feet, with considerable enlargement in places. Ore, fine grained sulphides, pyrrhotite, chalcocite, bornite, chalcopyrite, blackish green in appearance and generally high grade. On this vein are located the principal mines.

The Alta Group, consisting of two patented claims, and the four claims forming its southern extension (Occidental group), has been bonded to the Union Copper Mining Com-

pany, which owns the Union claims adjoining the Alta on the north. At the time of its greatest prosperity, between 1860 and 1870, the mine was equipped with steam hoist and air compressor; the incline was 455 feet deep and had four levels with over 1000 feet of drifts, besides an adit drift reaching the incline from the adjoining gulch. A second vein, east of the main vein, was opened by a winze below this drift and ore of 15 to 18 per cent taken out. There was also a lively mining camp, Altaville, with several hundred inhabitants and some substantial buildings. It has completely disappeared. An opening among the trees is all that is left of where the town once stood, and a few rusty iron bolts and charred timbers indicate the site of the shaft house. The mouth of the incline is caved in, but it is believed that this caving does not extend far down, because an ore car dropped into the incline became wedged, forming a bulwark against the falling ground. On an old map of the mine of 1867, the ore in the drifts below the first level is all marked as carrying from 10 to 11 per cent copper. Records of shipments made to Swansea and Germany in 1863 and 1864 show returns of $41 to $102 per ton. The company which has the option on the mine intends to first open the tunnel from the gulch, hoping to find the lower workings open to permit an examination. On the northern extension of the vein, adjoining the Alta, the Union Copper Mining Company, I. N. Turner, Salt Lake, president, owns two claims and a fraction, 3600 by 600 feet. On the first claim, not far from the Alta line, a strong outcrop of gossan with some sulphides marks the course of the vein which can be easily traced through nearly the entire length of the property and has been exposed in several cuts. One cut on the second claim shows oxidized ores, which are reported to assay 25 per cent copper. There are two old tunnels on Union No. 1 running nearly east and west into the mountain. The upper tunnel runs straight 300 feet, thence a drift with an upraise runs 100 feet south, turning east again, and reaches the face of the vein below the gossan outcrop. This part of the workings has badly caved and is almost inaccessible. The lower tunnel, 400 feet farther north, is 450 feet long, and from its end a drift turns 100 feet south along the vein. In this drift a winze has been sunk on ore

60 feet. It has been cleaned out and a drift was discovered in the bottom running south 20 feet. It is reported that 4 feet of ore was found in it assaying 17 per cent copper.

The Mammoth Group of fourteen claims adjoins the Union property in the north; it is owned by the Atlantic Pacific Copper Company, H. F. Sowers, president, Atlantic City, N. Y. There are two old tunnels on the property, 500 and 700 feet long.

Frank Zaar owns four claims west of the Union, with a 350-foot tunnel, and two claims in Hanscom Camp, with a 500-foot tunnel and 30-foot shaft.

James Bagley owns two claims in the same camp, with a 450-foot tunnel and a caved-in shaft in a big outcrop of iron and sulphides.

DIAMOND CREEK DISTRICT.

Bear's Nest Group.—Eight claims on west side of the North Fork of Smith River, near the Oregon and California state line; owned by Isaac Dietrick, of Smith River, Malone Bros., Mr. McNamara et al. Developed by a long tunnel and open cuts; ore forming a lode 9 feet in thickness and consisting of pyrrhotite and other sulphides, with some gold and silver.

Five Diamonds Group.—Five claims, situated on Diamond Creek; owned by C. W. Baker, of Medford, Oregon, Harvey Colson et al.

Keystone Group.—Two claims situated on the North Fork of Smith River, near the State line; owned by Isaac Dietrick. Developed by short tunnels and open cuts. The formation is serpentine. The ores are copper glance, red and black oxides, carbonates and native copper. Five tons of ore which was shipped to a reduction works had a reported value of 62 per cent of copper. Magnetic iron also appears in the claims.

McKee Claims.—Three or more claims situated near the mouth of Diamond Creek on the North Fork of Smith River; owned by Simon McKee, Smith River.

SHELLY CREEK DISTRICT.

Alameda Group.—Two claims on Shelly Creek, one half mile west of station; owned by J. E. Hill & Son, Shelly Creek. Developed by short tunnels. Formation diorite. Ores are pyrite and chalcopyrite, with quartz and waste matter. Sulphide values reported at about 3 per cent in copper, but ore is said to carry considerable gold.

Call Group.—Two claims on east side of Shelly Creek, one half mile east of station; owned by F. B. Edwards. Developed by tunnels and shafts. The ore is pyrrhotite and chalcopyrite, forming irregular bodies in serpentine, and carrying some gold.

Eva Group.—Three claims on Patrick Creek, one mile west of Anderson's station; owned by J. B. Hill, Shelly Creek, et al. Tunnel with shafts and open cuts. Good sulphides occur in quartz. The lode is said to be 15 feet wide.

Prudential Group.—Six claims situated on Shelly Creek, one mile north of Shelly Creek station; owned by the Prudential Mining Company, H. S. Reed, Medford, Or., manager. Developed by a tunnel and a shaft, with crosscuts on the lode. The ore lies in two bodies with north and south strike, dipping east 30 degrees. The upper vein has a thickness of 25 feet, the lower one being still thicker. The ore is sulphide of iron carrying small percentages of copper and zinc. The chief values are in gold content. The lode has been traced for more than 1000 feet on the surface.

Tuesday Morning Group.—Eleven claims, one and a half miles southwest of station on Shelly Creek; owned by J. E. Hill & Son. Carries some good ore, consisting of pyrite and chalcopyrite, with some gold.

OTHER DISTRICTS.

Del Norte Group.—Two claims one mile north of Adams station, Smith River, owned by Mary Adams; good ore found, consisting of sulphides with some magnetic iron.

Doctor Rock Group.—Five or more claims situated near the head of Blue Creek, twenty miles north of the Klamath River; owned by Thompson Bros., Requa, Cal., et al.

Higgins Mountain Group.—Five claims, situated on the Siskiyou Fork of Smith River, five miles south from mouth of Monkey Creek; owned by James Higgins, of Smith River, and James White. Development work consists of open cuts. Ore consists of high-grade copper glance, oxides, and carbonates, forming irregular shoots in serpentine.

Monkey Creek Group.—Six claims, three miles east from the mouth of Monkey Creek, on the Middle Fork of Smith River; owned by W. L. Higgins & Sons, of Smith River. Developed by short tunnels on opposite sides of the canyon. The ore is pyrite and chalcopyrite in dioritic rock. The values of the sulphide are said to range from 3 to 8 per cent in copper.

TRINITY COUNTY.

Trinity County lies in the heart of the Coast Range, and comprises a very large portion of the vast and slightly developed mineral region of northern California, being approximately 50 by 100 miles in width and length. It lies south of western Siskiyou County, whose characteristics it shares, and its eastern boundary is the summit line dividing the watersheds of the Sacramento River and the direct Pacific slope. Humboldt County separates it from the sea on the west. The entire surface of the county is mountainous, is profusely watered by the Trinity River and its numerous tributaries, and is quite densely forested. Owing to a remoteness from railroads, the great natural resources are very slightly developed. The population is sparse. The forests are practically untouched by the lumberman, and most of the county yet belongs to the public domain.

Over half the county is mineral-bearing, and mining is almost the only industry. There is a vast extent of auriferous gravels accompanying the present streams and also composing high-lying ridges and benches which mark the course of an ancient river through the northern and central parts of the county. The early surface placers, now exhausted, were

exceedingly rich, and at an early day the old gravel deposits referred to, in places hundreds of feet deep, began to be mined by the hydraulic process. For many years hydraulic mining has been the chief form of the industry in Trinity County, and, since the legal restriction of hydraulic mining on the Sierra slope, the largest hydraulic operations of America have been those by the Trinity, near Junction City. As the Trinity and Klamath are not navigable, hydraulic mining is here unhampered by law, and extensive new enterprises are under way. Large gravel deposits are favorably situated for gold dredging, which is assuming importance in this county.

Quartz mining has begun to make general progress. A number of important gold mines have been developed in the past, notably the Brown Bear at Deadwood, which is reported to have produced $6,000,000. In numerous large quartz mining districts valuable mines have been developed, and there is much mining activity in spite of the handicap of 50 to 100 miles distance from railroad facilities. Like Siskiyou County, this is an ideal field for the prospector. One of the most important quicksilver mines of the State, the Altoona, has but recently entered a long productive career. This is the chief platinum-producing county of the State.

The copper prospects of Trinity County are perhaps more widely scattered than those of any other county in northern California. They may be grouped, however, in three districts, or belts, all of which are essentially areas of peridotite. Few of the prospects are of very great magnitude, and most of them are too inaccessible for present economical working. Still, some of the prospects contain ore of high grade, and at least one of them has supplied remunerative shipments of ore. The districts may be designated as the South Fork, the New River, and the Trinity Fork.

The South Fork district includes a number of scattered prospects lying to the east of the South Fork of Trinity River, between Hyampome Valley and Rattlesnake Creek. The New River district includes a few prospects on the various branches of New River, some of which have considerable merit, and if they were more accessible would no doubt already have been worked. The Trinity Fork district includes

the copper prospects to the north of Trinity Center, near Carrville, and along the main branch of Trinity River.

The expense of working these prospects is apparent when it is remembered that the ordinary freight rates from Weaverville or Trinity Center to Redding approach $15 per ton, while the added cost from the mines to these points is often large. In spite, therefore, of the natural advantages of timber and water power, copper mining in Trinity County has not yet progressed very far. The principal copper prospects of the county are the following:

SOUTH FORK DISTRICT.

Cold Creek Group.—Seven claims on the Cold Fork of Indian Valley Creek; owned by J. R. Bloom and D. T. Goe, Hyampome. The country is exceedingly rugged. The formation is serpentine and diorite. The ore occurs in small bodies or bunches, consisting of quartz carrying some sulphide, not of high grade. Open cuts constitute the present development. Water power and timber are plentiful.

Lambert Group.—Three locations on the South Fork of Trinity River, near the mouth of Rattlesnake Creek; owned by Washington Lambert & Sons, Hay Fork. Ore forming small veins of chalcopyrite and pyrite in diorite. Developed by short tunnels and shaft; sulphide of good grade.

Lone Pine Group.—Two claims situated in section 19, township 1 north, range 8 east, Humboldt meridian, near the mouth of Rattlesnake Creek; owned by David Murphy and Minnie B. Murphy, Blocksburg. Ore contains some sulphide, and occurs in diorite.

Maddox Group.—Three claims on Cold Fork of Indian Valley Creek; owned by A. L. Maddox, Hay Fork. The formation is diorite and serpentine. The ore occurs in small bodies apparently, although but little work has been done to show its extent. The ore consists of oxides, carbonates, and sulphides carrying some gold, and is said to carry from 5 to 30 per cent of copper.

Murphy.—Two or more claims in section 36, township 1 north, range 7 east, Humboldt meridian; owned by Minnie B.

Murphy and David Murphy, Blocksburg. Developed by three shafts and a tunnel some hundreds of feet long. The formation is serpentine, and the ore occurs in veins of white feldspathic rock carrying a little high-grade oxides, carbonates, and sulphide.

Pattie.—Three claims in township 1 south, range 7 east, Humboldt meridian; owned by Wm. Pattie, Hay Fork.

Vine Oak Group.—Two claims in sections 2 and 35, township 1 north and 1 south, range 7 east, Humboldt meridian; owned by Ira P. Collins, Hay Fork. Some development work has been done. The ore is of fair grade, but in small bodies as shown at present. The country rock is diorite; the ore carries some gold.

Extensive placer mining was carried on in the early days on the bars and tributaries of New River and it is still the most important industry in this part of the country, although lode mining has made great progress within the last few years. All the veins, perhaps with the exception of a few claims on East Fork, were originally worked for their gold values only, and no attempt was made to save the copper, of which a certain amount is found in all the ores. Recently, however, this metal has attracted more attention and has become itself the object of prospecting.

NEW RIVER DISTRICT.

Granite Group.—Seven claims on Quimby Creek, six miles above its mouth; owned by F. C. Patton, Frank Evans et al., Weaverville. The ore occurs in serpentine and slate at intervals along the entire chain of claims. Only a little development work has yet been done, though good ore is found and in considerable quantity. Some of the ore has a value of 25 per cent in copper, with some gold. Facilities for mining are good.

Nonpareil Group.—Four claims on the East Fork of New River, four miles above the mouth; owned by C. S. McAtes, Redding. The lode varies in width from 1 to 14 feet, but is not traced for a great distance. One tunnel on the property is 25 feet in length. The croppings of gossan are said to occur

along the strike of the lode for one mile. The average value of the ore is said to be about 8 per cent copper.

The Bear Tooth Mining Company, Frank P. Burris, president, Quinby post office, owns eight claims on the east side of New River, at an elevation of 2600 feet above sea level. It is claimed that four veins, from 1 to 4 feet wide, are on the ground, running parallel south by 10 degrees east, north by 10 degrees west, but all the development work has been done on one vein. The upper tunnel, 110 feet in, cuts the vein not far below its outcrop; the second tunnel of 125 feet is about 300 feet lower, and a third one, 120 feet in, has been started 400 feet below its apex. The foot wall is formed by a coarse hornblende rock, probably gabbro; the hanging wall by a dark, fine-grained rock, apparently an altered serpentine. The ore is of a complex character, sulphide of iron and copper, and probably arsenides, manganese, etc., in a gangue of quartz. In the upper part of the vein the ore is oxidized and less refractory. Besides the oxide of iron and carbonates of copper, chalcanthite, or sulphate of copper, occurs in the vein in considerable quantities. These ores were treated in a one-stamp Nissen mill, which was replaced by a Huntington mill of 8 tons capacity. The ore shows considerable free gold in panning.

The Birdie Mining Group.—Six claims; owned by H. Nonamaker and W. H. Hammond, Quinby post office. A flat vein, 1 to 2 feet thick, running east and west. Sulphide of iron and little copper in quartz gangue rock. The surface ore was treated in a stamp mill.

The Quinby Mining Company, owns six claims on Quinby Creek. A vein 4 to 5 feet wide, east by north 10 degrees, west by south 10 degrees, has been opened by two tunnels, the upper one 100 feet long, with 200 feet of drifts; the lower one, 120 feet below, 400 feet long. Ore quartz gangue with sulphide of iron and copper, oxidized in the upper parts and carrying sulphate of copper. Owing to the difficulty of transportation, each stamp has a separate mortar.

The Big Buck Claim, adjoining, owned by H. Nonamaker, shows some copper carbonate and sulphate in a 20-foot shaft. The veins on these two properties are in porphyry. Quinby Creek is a tributary of New River on the west, and crossing the

divide at its head is located the Horse Linto claim. Two open cuts in an iron outcrop show some pyrite of iron.

The Last Chance Group, on Panther Creek, shows a large gossan outcrop, running east and west. A tunnel has entered a body of iron sulphide with some copper.

Discoveries of copper are reported from Hyampom, between Smith and Hay Fork, of Trinity River, and it is stated that veins carrying chalcopyrite have been located.

TRINITY FORK DISTRICT.

Cinderella Group.—Two claims in section 9, township 37 north, range 7 west, Mount Diablo meridian; owned by P. A. Wagner and E. A. Wagner, Carrville. Developed by 300 feet of tunnels and a shaft 50 feet deep. The vein is reported to be 16 feet in width. The country rock is serpentine. Some of the ore carries 10 per cent of copper. This property joins the Copper Queen on the north.

Copper Button Group.—Two or more claims located in section 36, township 37 north, range 7 west, Mount Diablo meridian; owned by H. Z. Osborne, of Los Angeles, and Thomas Baker. Developed by short tunnels and open cuts. Ore occurs in connection with dikes of quartz porphyry in serpentine, and consists of oxides, carbonates, and sulphides. It is apparently of high grade.

Copper Queen Group.—Three or more claims situated in section 16, township 37 north, range 7 west, Mount Diablo meridian; leased by George H. Fitch, Redding. This property is developed by tunnels and a shaft. The formation is serpentine. The ore consists of the oxides and carbonates of copper, with a little sulphide at the lower levels.

Crown Point Group.—Three claims in section 18, township 37 north, range 7 west, Mount Diablo meridian; owned by George L. Carr, Carrville, and others. The ore body is said to be very wide and to be otherwise extensive.

Eureka Group.—Two claims in sections 17 and 18, township 37 north, range 7 west, Mount Diablo meridian; owned by H. F. Dimock, of Carrville, and L. M. Hoefler et al. The

ore is silicious, carrying a small percentage of copper sulphide. The property has 50 feet of tunnel.

LeBlanc Claim.—One claim on the south side of Copper Creek near Carrville; owned by George LeBlanc, Carrville. Only small amount of development; ore similar to that of the Copper Queen.

Shoemaker Claim.—One claim on East Fork of Trinity River; owned by Ed Shoemaker, Trinity Center.

Maitland Claim.—One or more claims on Ramshorn Creek, ten miles northeast of Carrville; owned by William Maitland, Abrams.

OTHER DISTRICTS.

Jackson & Carter Group.—Four claims in section 29, eight miles southeast of Hay Fork; owned by G. W. Carter and James Jackson, Hay Fork. Developed by shaft 40 feet deep. The lode is said to be 10 to 12 feet wide, but not traced for a great distance in length. Samples of the sulphide ore have assayed 10 per cent or more in copper, with some gold and silver.

Fortuna Group.—Consists of nineteen claims of unpatented land; owned by the Fortuna Mining Company, C. Sweet, president, Fortuna. Situated five miles from Humboldt County line, thirty miles from Bridgeville. Small amount of development, but shows conspicuous gossan croppings; accessible from Fortuna, Humboldt County. This property is near the Copper Queen group, near the head of Van Duzen River.

Iron Mountain Claim.—Consists of one claim, situated three miles southeast of the Copper Queen, near the head of Van Duzen Creek; developed only by open cuts; some low-grade carbonate ore exposed. Owned by Turner & Co., Dyerville, Humboldt County.

Copper Queen Group.—Consists of six claims, situated in sections 10 and 11, township 1 south, range 6 east, Humboldt meridian, and thirty-five miles southeast of Bridgeville, Humboldt County; owned by Joseph Hutchens, Anada, Trinity County. Developed by one 40-foot tunnel and some open cuts. Sulphide ore has been encountered in the tunnel, and gossan croppings are abundant.

CROPPINGS 60 FEET WIDE, ISLAND MOUNTAIN COPPER MINE.

CROPPINGS 130 FEET WIDE, ISLAND MOUNTAIN COPPER MINE.

Black Palangus Group.—Situated in section 36, township 1 north, range 6 east, Humboldt meridian; owned by Joseph Hutchens, and brothers, Anada, Trinity County. Developed by open cut 60 feet long, showing good copper ore, some of it reported to assay 17 per cent copper. Croppings are bold, and about 20 feet in width. This property is one mile east of the Copper Queen group.

Island Mountain Consolidated Copper Mine.—This important but slightly developed property, with its quite remarkable outcroppings, is situated ninety miles north of Ukiah, just over the Mendocino County line. It lies by Eel River, in sections 9, 10, and 15, township 5 south, range 6 east, Humboldt meridian, in the Horseshoe district, and comprises seven claims—the Leach, Shotgun, Annex, Island Mountain, Merritt, Gore, and Day. The development work consists of one crosscut tunnel running north 490 feet, one running on the vein northwest 40 feet, and several open cuts across the outcrop. The croppings can be traced for 800 feet, and are in places 130 feet wide. The vein has a northwest and southeast trend. The southeast end line starts on the north bank of Eel River, and the claims extend northwest diagonally across Lake Mountain to the south bank of Eel River, the river making a horseshoe bend. The vein is capped with large bowlders containing much copper and iron sulphides. Slides have occurred, and many bowlders have found their way to the river bed, a distance of 500 to 700 feet. One bowlder, imbedded about 100 feet north of the river bank, is 60 feet across the base, and is estimated to contain 4500 tons of copper sulphide ore. Large bowlders have accumulated along the north bank of Eel River for 500 feet, and one weighing 160 pounds is reported to have yielded 10 ounces in gold, 5 ounces in silver, and 4½ per cent in copper per ton. The long tunnel was started 50 feet north of the river bank, and extended across the country rock 490 feet with the view of cutting the vein. This work was done in 1899, by the London Exploration Company. No timbers were put in. The rains made the ground heavy and the tunnel caved at several places. In 1900 the shorter tunnel was run 40 feet, and its face was in solid sulphide ore. As far as the vein is exposed on the level, it has the appearance of dipping into the mountain at a very low angle.

HORSE MOUNTAIN DISTRICT.

A few years ago copper was discovered on Horse Mountain, in the Hoopa Range, which forms the watershed between Red Wood Creek and the Trinity River. The new district lies in township 6 north, range 4 east, on the dividing ridge between Red Wood Creek and Willow Creek, which attains an elevation of nearly 5000 feet above sea level. The formation is slate, serpentine, and gabbro, the latter forming the crest of the mountain, and porphyry in places. For miles along the ridge, near the contact of the serpentine and gabbro, indications of copper are found in the iron-stained formation, the color of the oxides, sulphides, and small seams of cuprite and chalcocite.

The Copper Glance Group, of twenty-six claims, is owned by D. Wilson, of Korbel, and Dr. W. L. Perrot et al., of Eureka, who established a camp and started a tunnel, intended to cut a gossan outcrop running north 55 degrees west.

Adjoining in the north lies the Blind Lead group of fifteen claims, owned by D. Wilson and E. A. Walker, of Eureka. Indications of copper are found in many places.

Rich float and ore were found on the eastern slope of the mountain, a short distance below the summit, on a group of fourteen claims owned by **George Henderson**, Eureka. Fine specimens of cuprite, copper glance, and native copper were found, of the latter a piece weighing over 400 pounds, which had to be broken up before it could be transported. So far, the source of this float has not been discovered, but several surface deposits of copper glance have been found from which enough ore was shipped, according to the owner's statement, to pay for all improvements, which include several open cuts, a well-equipped camp and a 180-foot tunnel. The copper glance occurs in form of impregnated ore deposits, in the serpentine, without any indication of vein formation, except that they are found on the same level in a general direction southeast-northwest.

I. Charles Blake, post office Korbel, owns four and a half claims adjoining the preceding group, with an iron outcrop running southeast-northwest. On this property a small deposit of pure copper glance of the same character was opened up by an open cut without a vein being found.

post office, is seven miles distant. Owners, J. R. Dollison, of the Eureka Bank, and others, Eureka, Humboldt County.

La Perin Group.—Joins the Red Cap mine on the north, displays same formation, and consists of ten mineral locations on the strike of the contact, which is north. Owner, J. La Perin, Orleans Bar, Humboldt County.

Red Lasseck.—Situated seven miles southwest of the Copper Queen group in Trinity County, in township 1 south, range 4 east, Humboldt meridian, and is on the south side of Lassen Creek, at an elevation of 5800 feet. The croppings appear of an oxide nature, reported to yield 9 per cent in copper. The formation of both walls is serpentine. The property can be reached over a trail from Blocksburg, Humboldt County, a distance of seven miles. Owners, C. B. Bulger and others, Anada, Trinity County.

Rainbow Group.—This property, consisting of nineteen claims, is situated in the Mattole mining district, sixty miles south of Eureka, in sections 19, 30, and 32, township 1 south, range 1 east; also in sections 12 and 19, township 1 south, range 1 west. The seacoast is fourteen miles west. The Eureka and Eel River Railroad runs to within thirty miles of Scotia. About the center of these claims an open cut has been extended 60 feet across, the vein matter showing carbonate ore in many places in the cut. Several trenches on the outcrop show the same character of ore for several hundred feet along the strike of the croppings. On the north end of this property a creek, tributary to Bear River, runs diagonally across the property, and has cut a deep gorge through the veins, showing carbonates somewhat extensively 100 feet in width. Wood and water are plentiful. The property is owned by an incorporated company (C. S. Taylor president, and H. L. Ford secretary) of Eureka, Humboldt County.

Crismon Group.—Consists of 80 acres of patented land; joins the Rainbow group of mines on the south, and is in section 8, township 2 south, range 1 east, Humboldt meridian. Several prospect holes have been sunk at intervals over the 80 acres, and carbonate ore has been found. The same situation prevails as at the Rainbow group as to wood, timber, and water. A. H. Crismon & Son, owners, Pepperwood, Humboldt County.

BOWLDER OF COPPER ORE 60 FEET ACROSS BASE, 30 FEET DEEP, 25 FEET ACROSS TOP, ISLAND MOUNTAIN COPPER MINE, TRINITY COUNTY.

BOWLDERS OF COPPER ORE ON NORTH BANK OF EEL RIVER, FROM OUTCROP 500 FEET DISTANT, ISLAND MOUNTAIN COPPER MINE, TRINITY COUNTY.

post office, is seven miles distant. Owners, J. R. Dollison, of the Eureka Bank, and others, Eureka, Humboldt County.

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slope, has a heavy rainfall. These and other characteristics it shares with western Trinity. The mountainous eastern portion is poorly supplied with roads and trails.

It is in a region of this nature that Humboldt's known copper deposits occur, and in their kind and occurrence they resemble those of Del Norte and Trinity counties. The copper claims now held may be grouped in three districts. The best known are in the extreme northern part near the Klamath River. At the head of Red Cap Creek, south of the river and on a high ridge, are copper indications which have caused considerable expenditure in prospecting in the past. Large pieces of bornite and native copper occur as float. North of the river, near the headwaters of Camp Creek, large bodies of low-grade ore are reported. Well toward the southeastern portion of the county, in the neighborhood of Lasseck Peak, are extensive surface showings of copper ores. This is northwest of the Mad River district across the line in Trinity County. West of Lasseck Peak, and not far from the coast, are groups of claims showing carbonates and but slight development. The leading copper properties of these districts are noted.

Red Cap.—This property consists of 57.66 acres in section 29, township 10 north, range 6 east, Humboldt meridian. It is situated sixty-seven miles northeast from Eureka, and is reached by railroad twenty miles to Blue Lake, thence seventeen miles to Blairs by wagon road, and thence thirty miles by pack trail. In the year 1880 considerable work was done on the property in running tunnels. Many specimens of native copper have been found at the base of the mountain in Boise and Red Cap creeks. The contact is very prominent for the entire length of property, serpentine being the foot wall and diorite being exposed on the hanging wall. Abundance of timber and wood is growing on the property. Red Cap and Boise creeks afford plenty of water for all practical use. The elevation at the base of the mountain is 450 feet, and on the ridge, where the contact is prominent, 2150 feet. The strike of the contact is north. On the west side of the contact, slides have taken place for several hundred feet down the mountain, and evidently the rich float that has been found on Red Cap and Boise creeks came with the slides. Orleans Bar, the nearest

post office, is seven miles distant. Owners, J. R. Dollison, of the Eureka Bank, and others, Eureka, Humboldt County.

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Crismon Group.—Consists of 80 acres of patented land; joins the Rainbow group of mines on the south, and is in section 8, township 2 south, range 1 east, Humboldt meridian. Several prospect holes have been sunk at intervals over the 80 acres, and carbonate ore has been found. The same situation prevails as at the Rainbow group as to wood, timber, and water. A. H. Crismon & Son, owners, Pepperwood, Humboldt County.

HORSE MOUNTAIN DISTRICT.

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I. Charles Blake, post office Korbel, owns four and a half claims adjoining the preceding group, with an iron outcrop running southeast-northwest. On this property a small deposit of pure copper glance of the same character was opened up by an open cut without a vein being found.

E. P. Shyer, Eureka, has located two claims continuous in the same direction, and found the same kind of ore in a shallow excavation.

COPPER BOWLDERS AT PATRICK POINT, HUMBOLDT COUNTY.

An interesting discovery was made at Patrick's Point, about six miles north of Trinidad. D. W. Stapp, of Santa

Cruz, was walking along the beach, which is covered with immense bowlders, when his attention was attracted by the peculiar greenish color of some of the waterworn, polished rocks. He broke off several pieces, which proved to be solid sulphide of iron and copper, containing over 9 per cent of the latter. Then he took samples of all the ore in sight and made a careful estimate of the quantity. When the assay gave a fair percentage of copper and the calculation proved a satisfactory value in sight, he bought the land on which this mine is situated, and began at once the preparations for shipping ore. It is over 300 feet to the top of the bluff and the ore is hauled up in a sled by a gasoline engine over a steep incline. Since it is certain that the ore could not have come far, and as some pieces with angular edges were found above the water line, there seems to be a fair chance to find its source. The lowest formation is sandstone, with schists and serpentine above.

TEHAMA, GLENN, AND COLUSA COUNTIES.

South of Shasta County and the head of the Sacramento Valley, the eastern slope of the Coast Range is, for a long distance south, embraced in the western portions of the three large Sacramento Valley counties of Tehama, Glenn, and Colusa, the western boundaries of which are along the range summit. Tehama reaches across to the Sierra slope, and the others have the Sacramento River for their eastern boundaries. These counties are preëminently agricultural and horticultural, and have cut small figures in the mineral industry of the State, though, especially in the case of Colusa, this has been because varied and valuable mineral resources have been but slightly exploited. Their mineral resources are found along the Coast Range slope, which displays similar topographical, geological, and other characteristics throughout the three counties. This slope is fairly well watered, poorly wooded, and slightly settled, except in small fertile valleys. The lower foothills through the three counties present a long belt showing promising indications of petroleum and natural gas, which have for many

years been the subjects of more or less prospecting. Along this slope, at higher altitudes, various mineral substances have long maintained attention that has generally been unrewarded. Nature has been most generous with Colusa in this regard, and its western portion from valley plain to range summit displays well-known occurrences of quicksilver, sulphur, coal, mineral waters, gold, copper, building stone, etc., many of which are now receiving attention and inducing considerable investment. In 1900 Colusa produced some quicksilver and mineral water, Glenn yielded no minerals, and Tehama was credited with only brick.

Through these counties the known copper deposits are ranged in a north and south belt, high up on the slope, parallel with the range and about 50 miles west of the Sacramento River. This belt runs from the west-central part of Tehama County south through Glenn into the northeastern portion of Colusa County, whence it is prolonged into Lake County, and its course through the three valley counties is about 60 miles in length. The deposits to be noted are mainly in the columns of townships numbered 6 and 7 west, Mount Diablo meridian, some others lying in township 8 west. All are but a few miles below the summit line. This zigzag line of deposits follows a serpentine belt, and the copper ores are characteristically found inclosed in serpentine. The copper exists in various mineral forms, those most frequently noted being red and black oxides and carbonates, while native copper in the form of float is found at various points. The ores frequently carry some gold, and they generally occur in narrow and often rich seams between layers of serpentine, but the deposits opened so far have been small.

Copper deposits in Colusa and Glenn counties were first discovered in the early sixties, and this region shared the general copper excitement of that period. Two attempts at reduction in small smelters in the sixties and seventies, respectively, failed because the processes were not adapted to the ores, and no profitable or notable operations have ever been conducted in these counties. Some slight shipments of ore have been made in past years, and quite a number of claims have been opened to a small extent, but all exploration to date has been superficial and little is known of the value of the

copper belt described. The frequent richness of the ores suggests the probable worth of a large deposit if one were discovered. Those described in the following notes are the chief ones now held and known as copper propositions, but they cover a small part of the mineralized belt in which they belong.

TEHAMA COUNTY DEPOSITS.

Kestner & Thompson prospected a claim in section 4, township 27 north, range 7 west. They have three tunnels. The vein, 4 to 5 feet in width, is in serpentine.

Elder Creek Groups.—In section 20, township 25 north, range 7 west, and in sections 9, 10, 15, and 16, township 24 north, range 7 west; comprise three claims owned by W. Richards, five claims belonging to F. T. Notz, three claims to A. Henley, and three claims to George W. Cooper. All show some copper indications.

L. E. Perine worked on copper stringers in section 25, township 27 north, range 8 west.

White Bluff Group.—In sections 4, 5, 8, and 9, township 25 north, range 7 west; belongs to B. N. Huestis, of Red Bluff, and consists of six claims. They are in the chrome district. Some copper indications. Slight development.

Tom Head Copper Mine.—This property is located in section 25, township 27 north, range 9 west, Tehama County. It is forty-two miles by good wagon road from Red Bluff, and at an elevation of 4150 feet. Strike of vein northwest and southeast; dip probably to the east. There is a gossan capping 25 to 300 feet in width on the surface. Power was developed by 60-horsepower steam boiler. Water power, however, under development. Plant has a three-drill Sullivan compressor and 60-horsepower boiler. Area of property about 2000 acres; about 400 acres patented, balance held as mineral locations. Development is on two levels. On upper level two tunnels cut the vein some 70 feet apart, and drifting has been done to connect both levels, and north and south from each, showing vein continuously for some 250 feet and ore for nearly that distance. Lower level was driven to tap the vein at a point 150 feet below upper level, about 135 feet. Value of ore

reported at $15, gold, silver, and copper, present prices. Property is owned by the California and Massachusetts Copper Mining Company, organized and doing business under the laws of Wyoming, and leased to Chicago Copper Refining Company. The particular mineral claim worked is known as the Uncle Sam. There is no present regular output from the mine, as the property is simply under development.

Four locations belonging to the California and Massachusetts Copper Mining Company (N. E. Guyot, manager; E. Burrill, superintendent, post office, Red Bluff) are reported by owner's representative:

Tom Head.—In section 31, township 27 north, range 8 west, 5-foot vein in greenstone, course northwest-southeast; dip slightly northeast, containing carbonate ore; development, open cut and 30-foot tunnel.

Uncle Sam.—In section 25, township 27 north, range 8 west, 24-foot vein; strike, northwest-southeast, between lime foot and greenstone hanging wall. Ore, sulphides and some native copper. Three tunnels of 60, 300, and 114 feet, with 200-foot drifts.

The Halley.—In section 5, township 26 north, range 9 west, and

Verde.—In section 24, township 27 north, range 9 west, are in slate and lime. Undeveloped.

GLENN COUNTY DEPOSITS.

Hudibras Claim.—In section 1, township 19 north, range 7 west. The formation is serpentine. A shaft 6 feet deep shows some copper indications. Owner, Briscoe Oil and Mineral Company. The same company owns land in sections 2, 11, 12, and 13, whereon copper indications occur.

H. D. Knight owns land in sections 18 and 19, township 19 north, range 6 west, showing copper indications.

St. John Development Co.—Owns land on which there are iron-capped copper indications in section 18, township 18 north, range 6 west.

Indications similar to the above occur in sections 12, 13, and 24, township 18 north, range 7 west.

Black Buttes Copper Claim.—In sections 30 and 31, township 24 north, range 8 west. Owner, J. A. Bedford. There are here fine indications of red oxide scattered around in bunches, but no vein.

There are the remains of an old town, Peckville, in section 18, township 18 north, range 6 west, where in the sixties there was a large amount of prospecting for copper and gold. Old tunnels and shafts are frequent. To the north of Chrome Mountain, two miles, A. W. Lehorn owns claims where there are good copper indications; formation serpentine. Development consists of a tunnel 200 feet long. Large pieces of native copper are here found, some weighing about two pounds.

South from the Black Buttes, along Grindstone Creek, and following the creek twenty-five or thirty miles to Stony Creek, it is all a copper mineralized country.

COLUSA COUNTY DEPOSITS.

Gem Group.—Located by W. W. Heard and others consisting of fourteen claims in section 28, township 16 north, range 6 west. Nearby are two claims owned by Raymond Houx and Edward Swinford, all showing indications of copper.

Blackbird.—Owned by C. L. Heard et al.; in sections 19 and 20, township 16 north, range 6 west. Ledge is in serpentine.

Gray Eagle.—The most important location in this neighborhood is owned by W. N. Heard and J. W. Simons. It lies in section 20, township 16 north, range 6 west. It is developed by open cuts and a shaft 20 feet deep. The vein formation is of unknown width, but a seam of copper-bearing rock is exposed that shows from 18 to 48 inches in width. This does not appear to have much regularity. A tunnel run 200 feet does not reach the vein in depth. The ores are native copper in serpentine and red and black oxides. Along the lode ores carrying native copper can be found as float.

Pacific Claim.—It is about two miles southeast of the Gray Eagle, in section 28, township 16 north, range 6 west. Here a shaft was sunk 50 feet on a bunch of ore, which was then all extracted and shipped. There are two other shafts, one

25 feet, the other 45 feet deep. The formation is serpentine, and the ores are oxides of iron and copper, carrying some gold.

There are several other prospect holes, showing small amounts of copper ores, in township 16 north, range 6 west.

Ruby King Copper Mining and Townsite Co.—A Sacramento corporation owns and has opened eleven claims in sections 29 and 32, township 17 north, range 6 west. No great development, and no large deposits are yet shown. The principal indications on this group are float copper.

On the ground of the Mark Hanna Oil Company, in section 35, township 17 north, range 7 west, there are indications of copper ore.

Lion Mine.—On this old property, the present owner of which is J. F. Easton, there has been considerable work done in the past.

MENDOCINO COUNTY.

Mendocino County knows little of the mineral industry in any of its forms, but carries various economic minerals in its mountains, prominent among which is copper, of which many surface showings occur. The county occupies about 85 miles of the coast line south of Humboldt, and in its widest part reaches 60 miles eastward to the summit of the Coast Range, where it meets the valley county of Glenn. Its southern half shares the higher mountain region with Lake County. Mendocino has rich agricultural valleys, the chief ones being those of the Eel and Russian rivers. The redwood belt extends through the county, and lumbering is the chief industry. The lower elevations afford extensive grazing lands. Mineral springs and an extensive undeveloped coal region in the northern part provide the best known mineral features.

Copper occurrences are sporadic and form no "belts." They are found along the eastern side of the county and across the southern end to the range nearest the coast. As elsewhere in this general coast region, they vary in nature, displaying carbonates most frequently and occurring in metamorphic forma-

tions. Several prospects display rich ores in small quantity, but the prospecting that has been carried on intermittently for many years has not yet revealed any notable deposits.

In the northern part of the county, the Thomas property has been long prospected because of rich indications, but no large ore bodies have been found in place. Promising indications are reported from Potter Valley in the east central part. Most of the known prospects are in the southern, and especially the southeastern portion, south and east of Ukiah, the county seat, near the Lake County boundary.

Thomas.—On Bralt ridge, at the edge of Eden Valley, fifty-five miles north of Ukiah and three miles south of Carey. A mass of rich sulphides of iron and copper has caused considerable prospecting in search of a vein.

Native Copper.—On Red Mountain, twelve miles southeast of Ukiah. A shallow cut shows a stratum of serpentine about 3 feet wide, carrying native copper and copper minerals. The stratum is inclosed in serpentine.

Red Mountain Group.—Four claims, ten miles southeast of Ukiah, in section 23, township 15 north, range 11 west. Apparently two veins exist. These claims were located in 1890, and relocated from time to time. The formation is principally serpentine. One claim is developed by an open cut and cross-cut tunnel. Several small bunches of ore have been found in the cut, showing green carbonates and metallic copper. An adjoining claim is developed by two shafts 100 feet and 50 feet deep and by an incline. From one shaft, above the 50-foot level, bunches of carbonate ore were taken out in 1896. One ton of ore shipped to San Francisco yielded $12 in excess of transportation and working charges. The shaft was extended to the 100-foot level, showing no ore, the bottom being in broken sandstone and clay. From an incline several tons of low-grade ore have been taken out. Other openings have yielded nothing of interest. Owners, Huff & Gibson, Ukiah.

Ogle.—This mine is situated in the Anderson Valley district, comprises 2000 acres of patented land, in township 13 north, range 12 west, and joins the Redwood Copper Queen

mine on the north. This land was bonded to Cloverdale people. A shaft 16 feet deep on the center of the claim exposed carbonate ore. Not enough work has been done to demonstrate the width of the vein or the formation of the walls. Gossan 2 to 3 feet wide can be traced for one mile through the claim. The conditions attending the Redwood Copper Queen obtain. Owners, Ogle Brothers, Ornbaun, Mendocino County.

McGimpsey.—In sections 17, 13, and 18, township 13 north, range 12 west, fifteen miles southwest of Ukiah, comprising eight full claims. The formation is serpentine. The open cuts have exposed considerable copper stains, and in a few places some red oxide of copper mixed with oxide of iron. The work shows an irregular diffusion of cupriferous material through the mass of eruptive rocks. Owner, C. P. McGimpsey, Ukiah.

Pieta.—One claim, ten miles northeast of Cloverdale, four miles from the Sonoma County line. It is developed by an open cut 55 feet across the vein matter. Croppings can be traced through the claim, the strike of the mine being east. The ore carries a slight trace of carbonate of copper, the gangue matter is mostly magnetic iron, and serpentine is the formation of both walls. Owners, J. G. Caldwell et al., Healdsburg, Sonoma County.

Redwood Copper Queen.—Consists of 840 acres of patented land in sections 17 and 20, township 12 north, range 13 west, Mount Diablo meridian, and is thirty-five miles southeast of Ukiah. The development work consists of nearly 200 feet of tunneling to a point in the vein where a chamber has been excavated 16 feet square, exposing sulphide ore. Two winzes have been sunk at this point, 100 and 36 feet, respectively. The vertical 100-foot winze was started near the foot wall, and sulphide ore exposed the entire depth. The foot wall having been encountered at this level, work was then abandoned, and a second winze started on an incline of 65 degrees northeast and showing sulphide ore. The lode is very much broken, and the walls very irregular, caused doubtless by faults that are prominent on the surface. The walls on the tunnel level are respectively broken porphyry and sandstone. A gossan capping 2 to 4 feet wide can be traced

one mile through the property. The surface soil is in some places from 6 to 8 feet deep. The ore carries gold, silver, green and blue carbonates, black and red oxides, gray copper and copper pyrites. The company is a San Francisco corporation. W. P. Ferguson, president; Thomas Mellersh, secretary and treasurer, San Francisco.

LAKE COUNTY.

Lying wholly within the Coast Ranges, with the line dividing the watersheds of the Sacramento River and the Pacific for its eastern boundary, inclosed between two ranges and containing an especially rugged portion of this mountain system, Lake County has varied mineral resources, though its mineral output is relatively small. Its many scenic attractions have made it called a little Switzerland. It is a region of much and recent volcanic action. It has many mineral springs, some of which are famous resorts, and by these Lake County is mainly known to the outside world. Cinnabar is its chief mineral resource, and it is now one of the important quicksilver counties. Its other minerals are gold, silver, copper, borax, sulphur, asbestos, chrome, natural gas, etc.

The cupriferous belt passing through Tehama, Glenn, and Colusa counties reaches into Lake at the north. Here, near the head of Little Indian Valley, a mineralized belt carrying copper extends several miles, and at one time there was quite a copper excitement caused by the finding of large pieces of native copper and rich oxide ores. The Lyon property gave rich prospects and several thousand dollars were lost in an ill-managed attempt to smelt the ores. Copper is elsewhere mainly found in the southern portion of the county below Clear Lake, and in the central west near the head of Clear Lake and across the line from the chief copper occurrences of Mendocino County. Three properties are noted.

Copper Prince Mining Co.—Property consists of three claims, four miles northwest of Middletown, in section 19, township 11 north, range 7 west, in the southern part of the

county. Developed mainly by one tunnel and two open cuts on the vein, showing the vein to be from 6 to 8 feet wide, with limestone walls. Heavy gossan can be traced through the claims. The company surveyed on the north slope of the ridge preparatory to starting a tunnel with the view of cutting the vein on deeper levels. The ore on the tunnel level is impregnated with blue and green carbonates, and is reported to assay 5 per cent in copper, $3 in gold and 1 ounce of silver. President, E. Lobree; secretary, J. C. Ruddock, Ukiah.

Christianson Tract.—This comprises 294 acres in township 13 north, range 7 west, and is three miles south of Clear Lake. Considerable float has been found on the low lands, evidently coming from the high ridges that are somewhat prominent throughout the tract. Several pieces of float have been assayed, and are reported to contain 65 per cent copper. In 1879 a tunnel was run about the center of the ranch, 112 feet north, on a contact of serpentine and limestone, but no vein was found in place. Owner, Peter Christianson.

Poe Claim.—Seven miles north of Lakeport, in section 27, township 15 north, range 10 west, a shaft of 35 feet was sunk and a tunnel of 65 feet was run in 1870. In 1900 parties relocated and ran an open cut 25 feet long on the south end croppings. The vein is 5 feet wide, in a serpentine belt, and shows a light trace of carbonates. There are ten sulphur springs at the north end of the property. Owners, H. B. Wells, A. Smythe and James Lee, Lakeport.

NAPA COUNTY.

Napa County is one of the most favored and fertile counties of the Coast Range region. It lies south of Lake County and east of Sonoma, and reaches south to San Pablo Bay. Topographically it is mainly composed of the rich and populous Napa Valley, and of two flanking mountain ranges. At the head of Napa Valley, at the northern end of the county, is Mount St. Helena, altitude 4343 feet, the highest point in this

part of the Coast Range. Napa is mainly a fruit, grain, and vine-growing county, but it also possesses a variety of mineral resources, those of greatest present importance being quicksilver and mineral waters. In the northern portion of the county are some of the important quicksilver mines of California, and some of its mineral springs are widely known. Other mineral resources are gold, silver, chromium, iron, manganese, and building stone. In 1900 Napa County's mineral output amounted to $493,100, and in 1899 to $701,416. Copper occurs sporadically, as in adjoining counties. Two deposits are noted.

Napa Copper Claim.—One claim, situated thirteen miles south of Middletown, in section 17, township 10 north, range 5 west; developed by a crosscut tunnel south 400 feet. A gossan capping can be seen through the entire plain. Several years back a shaft was sunk 50 feet on the west end of the plain, and reported to have encountered several bunches of high-grade sulphide ore. A new corporation was organized, and work was resumed. A 700-foot tunnel was started on the north side of the mountain, with the view of cutting the vein 300 feet from the surface. The country formation is serpentine. Owners, Napa Copper Company—Owen Wade, president; T. A. Taylor, secretary, St. Helena.

Search Group.—This property consists of eight continuous claims, seventeen miles north of Napa, in section 5, township 6 north, range 5 west. Very little work has been done. There has never been any vein found in place, although considerable float, consisting of sulphides, has been picked up on the slope of the mountain. The formation is serpentine. Several years ago several crosscut tunnels were run north, but were not extended far enough to encounter the vein. The capping has an east and west trend, is 2 to 4 feet wide, and is sprinkled with blue and green carbonates. Owner, E. F. Rossan, Glen Ellen.

SONOMA COUNTY.

Quite a number of copper deposits of minor importance, as far as developed, are found in the bay county of Sonoma, which lies for nearly 60 miles along the sea south of Mendocino, extends back some 40 miles to the summit of the main Coast Range, opens on San Pablo Bay at its south, and leaves the small county of Marin occupying the peninsula opposite San Francisco. The county is traversed by several low north-and-south ranges, and possesses some of the largest and most famous of the horticultural and agricultural valleys of the State. These fertile valleys are the chief fountains of its life and wealth. The redwood belt near the coast supports an extensive lumber industry. Of minerals, the county possesses a variety. There are slight occurrences of gold and silver, and scattered deposits of iron, coal, manganese, mineral paint, chrome, clays, building stones, etc.

The copper ores discovered form no connected belt, but occur within two vertical tiers of townships through the central region of the county. The occurrences are similar to those of adjacent coast counties. Several prospects have been opened by superficial shafts, tunnels, and cuts, a few tons of ore taken out and slight experimental shipments made in past years. Several properties have been reopened.

Wall Tract.—Consists of 200 acres of patented land five miles southwest of Santa Rosa, in section 30, township 8 north, range 9 west. Several pieces of rich copper float have been found on the tract, but as yet no vein in place. A shaft 10 feet deep has shown native quicksilver. Owner, H. C. Wall, Hilton, Sonoma County.

Archer Tract.—This tract joins the Wall tract on the north, and comprises 288 acres of patented land in township 8 north, range 9 west. In 1880 considerable rich float was found and shipped, and two tunnels run north on the contact, 250 feet apart, for a distance of 200 feet. No vein was found in place. The tunnels were abandoned. Interest was later renewed, owing to rich float being again found. The formation is serpentine and sandstone. Owner, J. H. Archer, Healdsburg, Sonoma County.

Healdsburg Lode.—One claim, ten miles north of Healdsburg, on Black Mountain, in section 31, township 11 north, range 9 west. A very prominent gossan cropping extending several feet above the surface runs through the claim. The property was opened many years ago by a tunnel which penetrated nothing but limestone. The owners ran a crosscut tunnel on the west slope of the mountain, with a view of cutting the vein 100 feet from the surface. The elevation on the summit of Black Mountain is 2500 feet. Owners, Ed Ellis and J. G. Caldwell, Healdsburg.

Grizzly Claim.—This property, ten miles northwest of Healdsburg, is situated on Pine Creek, in township 9 north, range 10 west, and was relocated. Croppings, principally quartz, carry copper stains. Old works consist of two caved tunnels on the south slope of the mountain 200 feet apart, running west 100 feet. The formation is sandstone on the north and serpentine on the south. Owners, C. F. Brandt et al., Healdsburg.

Ward Tract.—Consists of 591 acres of patented land, five miles west of Healdsburg, in section 22, township 9 north, range 10 west. Gossan croppings can be followed for one mile eastward through the tract along a contact of limestone and serpentine. Some very rich copper float has been found on the tract, but no vein has been discovered in place. Owner, J. W. Ward, Healdsburg.

Altamont Group.—This property is eighteen miles northwest of Santa Rosa, in section 17, township 7 north, range 10 west. It is developed by an open cut and shaft. The croppings consist of a gossan capping several hundred feet in length, which exposes a vein 5 feet wide of copper carbonates. The formation on both sides of capping is serpentine. At the end of the open cut a shaft has been sunk on the vein matter. Owners, J. D. Connelly, James Owens, H. M. LeBaron, Occidental, Sonoma County.

Baby Jack and Earl Clare.—Situated seven miles northwest of Healdsburg and two miles west of Dry Creek, in township 9 north, range 10 west. In 1875 these claims were worked and several tons of copper ore shipped to San Francisco. Later they were abandoned and relocated from time to time.

The Baby Jack is developed by a 35-foot tunnel at the south end, on the strike of the outcrop, the face giving about 35 feet of backs. About the center of the claim a vertical shaft has been sunk 22 feet on the vein. The gangue of the vein is principally quartz carrying no copper sulphides, but stained somewhat with blue and green carbonates. The formation on the east is limestone, on the west serpentine. Considerable timber is growing on the claims. Owner, C. C. Echlin, Santa Rosa.

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MARIN COUNTY.

The small coast county of Marin, lying across the Golden Gate from San Francisco, presents a few small copper deposits among its slightly developed mineral resources, which include small seams of coal, iron, manganese, chrome, building stones, and clays. Brick and rubble are the current mineral products. Nearly forty years ago two copper deposits close to the shore, between Mount Tamalpais and Bolinas Bay, were opened by tunnels and later abandoned. One, in Union Gulch about three miles north of Bolinas, was opened in 1863 by the Union Copper Mining Company, which shipped several tons of ore for reduction. Efforts to develop a profitable supply of ore lasted seven years. In 1863 the Pike County Gulch Copper Mining Company opened another mine a mile south of the Union in Pike Gulch. During three years a 700-foot tunnel was run, but the enterprise was abandoned. In this neighborhood there is a 4-foot vein cropping carrying iron pyrites and covering low-grade copper ore. The ores in these deposits occur in veins, associated with quartz and lying in metamorphic sandstone.

Bolinas Copper Mining Co.—This company has exploited a copper property in the region described, four miles northeast of Bolinas Bay, in section 1, township 1 north, range 8 west, and twenty miles from San Francisco. The property consists of nine parallel copper-bearing veins encased in serpentine. The veins trend northwest, are vertical, and are from 6 inches

to 2 feet in width. On the western vein a shaft has been sunk 180 feet, and from it 2500 feet of drifts have been driven north and south on the 100 and 180-foot levels. In former times short tunnels were run on the veins to test their values, but these tunnels caved. The owner is the Bolinas Copper Mining Company; T. P. H. Whitelaw, president and manager, San Francisco.

ALAMEDA COUNTY.

Alameda, a rich and populous county lying on the eastern side of San Francisco Bay, made up topographically of fertile valleys and low ranges of the Coast system, has added copper to the list of economic minerals counted among its resources. It has been an important producer of salt, manganese, clays, building and paving stones, etc. A copper-bearing lode was discovered a few miles east of the bay shore, close to the city of Oakland, and directly across the bay from San Francisco. An exposition of it is contained in the following descriptions of the two properties in which development occurred:

Alma Mine.—This property embraces over 80 acres of land belonging to the Boehmer ranch, four miles east of Broadway, Oakland. Its development has been undertaken by the Stauffer Chemical Company of San Francisco, and consists of about 600 feet of tunnels, with some unimportant shafts and open cuts. The ore body forms a shoot of solid pyritic ore ("black pyrites"), apparently lenticular in shape, having a thickness of 12 to 18 feet. The shoot has been followed for more than 100 feet along its strike in a northwesterly and southeasterly course. Other shoots have been proved, in the near neighborhood. They occur along a zone or belt of indefinite width, ranging with the strike of the ore and crossing the canyon of Redwood Creek. The belt has been traced for a distance of about 3000 feet, including the deposits of this and the following property. The whole amount of ore available upon this property is very great. The ore zone follows very nearly along the line of contact between serpentine and a silicious rock resem-

bling a metamorphosed chert. Croppings of gossan also occur outside of the direct line of the main ore zone. The ore from this mine consists of the simple sulphide of iron and copper, the percentage of copper being low, ranging, it is said, between 1½ and 3½ per cent, and carrying gold to the value of about $2.50 per ton. The ore is mined chiefly for its contents of sulphur, of which it carries about 45 to 50 per cent. A representative analysis of the ore is given by the Stauffer Chemical Company, as follows: Sulphur, about 50 per cent; copper, 3 per cent; gold, $2.50, and silver one ounce per ton; silica, traces; balance, iron. The ore is shipped from the mine directly to the acid works of the Stauffer Chemical Company, or to supply the demands of other chemical companies depending upon the use of pyritic ores for their source of sulphur. The Peyton Chemical Company of San Francisco is a large consumer. This mine is important, not only for the present and prospective value it contains within itself, but from the fact that its development opens up the probability of still other similar deposits in this region, where similar geological conditions are not uncommon.

Leona Heights Mine.—To the south of the Alma mine and on the strike of its ore-bearing zone, is the mine owned and operated by the California Improvement Company, under control of the Realty Syndicate of Oakland, of which F. M. Smith is president. The ore body of this mine is similarly situated and is similar in character to that of the preceding property. It is developed by tunnels, showing a shoot of ore about 12 feet in thickness. The croppings of gossan (limonite) are very conspicuous at the surface.

CONTRA COSTA COUNTY.

MOUNT DIABLO DISTRICT.

This Bureau has received a communication from Messrs. John Neate, M.E., and Chas. Olaine, No. 425 Bank street, San Francisco, referring to copper deposits on Mount Diablo (elevation 3054 feet), from which are taken the following statements:

Some forty years ago some rich float found, especially copper glance, led to the discovery of copper ores, which attracted considerable attention and were worked to some extent, but under the conditions prevailing at that time they could not be mined to advantage, and were soon abandoned.

The correspondents prospected in that region in 1907 and found several veins carrying values of gold and copper in the ravines on the north and west slope of the mountain, running northwest and southeast, the same as the gulches. They report one lode from 80 to 100 feet wide in section 27, from which they obtained samples assaying from $4 to $26 in gold and 2 to 2½ per cent copper.

In section 26, on Mitchel Creek, they report veins carrying from 2½ to 10 per cent copper.

MERCED COUNTY.

Jose Copper Claim.—Located in the Coast Range in section 4, township 14 north, range 9 east, about thirty-five miles east of Hollister, the nearest railroad station. The development has exposed quite a body of ore, but so far the ledge has not been located. There is a tunnel 500 feet long, but little ore was encountered. A 30-foot shaft was sunk and a drift run about 60 feet, exposing a good body of copper ore. The ore was chalcopyrite, running high in gold and silver values. Idle. R. Jose, of Hollister, owner.

The Victor Bonanza Group.—Located in sections 30 and 31, township 13 south, range 10 west, and sections 14, 15, 16, 23, 24, and 25, township 13 south, range 9 west, sixteen miles southwest of Dos Palos, and thirty-five miles southeast of Hollister. The croppings show a mineralized belt extending five or six miles, and varying from 100 to 200 feet in width. Native copper and chalcopyrite are found frequently in the croppings. The formation is sandstone and porphyry. The ledge matter is quartz. Practically no development has been done, but the surface indications are good. M. T. Dooling, of Hollister, is president of the company.

SAN BENITO COUNTY.

Lewis Creek Claim.—The property is located on Lewis Creek, the southern boundary of San Benito County. It is sixteen miles from King City, on the Southern Pacific Railroad, and in sections 2, 3, and 4, township 19 south, range 10 west. The development consists of a 100-foot tunnel, which was intended to tap the ledge, but missed it. Nothing could be learned further than what could be determined from the croppings. The croppings may be traced for four miles. The ore is chiefly chalcopyrite. The formation is sandstone and serpentine. G. W. Spencer, of Hollister, and F. W. Saffel, of Lonoak, owners.

SAN LUIS OBISPO COUNTY.

Los Osos Mine.—Located eight miles southwest of San Luis Obispo, and on the south side of Los Osos Valley. The mine was worked forty years ago, and the ore hauled by wagon to Port Harford and shipped to Swansea. There is a good wagon road from the mines to San Luis Obispo. The ore

occurs in a porphyritic vein in sandstone and shales. A shaft 230 feet deep was sunk on the ledge, a tunnel 235 feet long was run to the bottom of the shaft, and good ore was found in the shaft and the tunnel. The works were not properly protected and were allowed to cave in, consequently all observations had to be made from the surface. Estate of J. M. Gleaves, San Francisco, owner.

Tiptop Claim.—Located ten miles north of San Luis Obispo and three miles southwest of Santa Margarita, a station on the Southern Pacific Railroad. There is a ledge 14 inches wide, carrying native copper. The country rock is shale and serpentine. No development has been done. A. Guillemin, of Santa Margarita, owner.

On the same ledge is the Gloria and the Tassajara mines, similar to the Tiptop, and owned by Mrs. R. Childs and F. Flores, of San Luis Obispo. No development work has been done.

Prodigal Son.—Six miles east of Cayucos, between Toro and Old creeks, and twenty-two miles west of San Luis Obispo. The development consists of a 50-foot shaft on the ledge and 100 feet of tunneling intended to tap the ledge 130 feet below the collar of the shaft. At the time of visit, the tunnel had not intersected the ledge. The ledge is apparently about 7 feet wide, carrying chalcopyrite, gold, and silver. The gangue is quartz. The formation is syenite and serpentine. E. P. Loring, of Cayucos, owner.

Sky Scraper.—Located seven miles east of Cayucos, on upper Toro Creek, and about twenty miles west of San Luis Obispo. The development consists of two tunnels, crosscutting the vein, one 250 feet and the other 103 feet long. Where the tunnels tap the vein the ledge appears to be about 10 feet wide. The ledge is porphyry, the formation granite, and the ore chalcopyrite. William Drought, of Cayucos, owner.

Schneider & McCles Claim.—On San Bernardo Creek, seven miles east of Morro. The owners had just begun to develop and had not encountered the ledge in the tunnel. Eight men were employed developing. Schneider & McCles, of Morro, owners.

Refugio Claim.—Located on Chorro Creek, about seven miles north of San Luis Obispo, on the west side of the mountain. The development consists of a 135-foot tunnel. A 4-foot ledge, carrying native copper and sulphide ore, was encountered. The formation is granite and serpentine. Mrs. R. Childs and F. Flores, of San Luis Obispo, owners.

Guerro Claim.—Located one-quarter mile north of Serrano station and six miles from San Luis Obispo. The ledge is in serpentine and shows copper in the croppings. Mrs. R. Childs and F. Flores, of San Luis Obispo, owners.

Guadalupe Claim.—Located one and a half miles from Serrano station and six miles from San Luis Obispo. The croppings show a ledge of quartz 2 feet wide in serpentine. Mrs. R. Childs and F. Flores, of San Luis Obispo, owners.

THE SIERRA NEVADA BELT.

The Sierra Nevada Mountain range contains copper deposits in wider distribution and probably in greater total quantity than any of the other general geographical divisions of California by which the copper resources of the State have been classified. Copper ores have been found practically throughout the length and breadth of the range, which runs for about 500 miles through the eastern side of the State, with a width of from 50 to 75 miles. The deposits are mainly concentrated along a mineral belt which appears high in the range to the north, sweeps southwestward toward the central valley of the State, and then continues for about 300 miles southeasterly through the western foothills, to disappear in Kern County near the southern end of the range.

Here is a definite copper belt approximately 400 miles long. From Nevada County southward it is known as the Foothill Belt, and with it the history of the copper industry of California up to 1896 is mainly associated. The other copper deposits of the range occur, with wide intervals, along both slopes, mainly in the base-ore mineral regions of the higher

portions of the range on both sides of the summit line, and especially on the eastern slope in Mono and Inyo counties. The copper deposits of these two counties on the eastern side of the range, in the Great Basin, are grouped with those of the general arid region of southeastern California. The few deposits along the higher western slope are little known and slightly explored. They carry also the precious and baser metals, and some surface prospects at high altitudes indicate ore bodies of possible future value. Throughout the base-ore belt of the high Sierras, which mining enterprise has not yet reached, and which has yet been but very slightly prospected, copper will probably be frequently found in the mineralized zones. Along the middle slope are here and there copper-bearing prospects worthy of incidental note.

Interest, however, is here centered in the belt along the western flank of the range, in which are the important developed copper mines of the State outside of Shasta County, and which holds much of the industry's promise for the future. It is an important feature of the gold as well as the copper resources of the State. The foothill mineral belt, as generally recognized, stretches from northern Nevada County for about 250 miles southward into Tulare County. For about this distance it has a continuity and a regularity of course that easily establish its identity, and from either end it may be somewhat vaguely traced farther by a series of occasional mineral deposits. There is but a general warrant of convenience for regarding the belt as prolonged northeasterly into the higher slope and for conceiving the 400-mile string of copper deposits of this slope as constituting one copper belt. So regarded, this belt exhibits a definite beginning at the north by the southern edge of the lava sheet that covers so many thousand square miles of the mountainous northeastern part of the State. Such a definite beginning is found on the southern slope of the Diamond Mountain range along the northern border of Plumas County, over 100 miles south of the Oregon boundary. In this region are bunched, in three or four townships, some of the large and probably important deposits of the belt. This is about 75 miles southwest of the eastern end of the Shasta County copper belt, and this intervening space is buried by the lavas which hide all mineral formations except where they

are revealed occasionally by erosion. Halfway on the direct line between these points is the extinct volcanic peak of Lassen Butte. It is likely that copper-bearing ores underlie this volcanic blanket, connecting the deposits of the Sierra slope with those of Shasta and Siskiyou counties to the northwest, and making one great copper belt reaching for about 600 miles through the eastern and north-central parts of the State into Oregon.

North of the Plumas County boundary, in southern Lassen County, there have been found slight occurrences of copper minerals, mainly as float, but no deposits worthy of note have been revealed in this much-disturbed and lava-buried region. Farther north in eastern Modoc County, in the Warner range of mountains belonging to the Great Basin, there are similar slight indications of copper deposits, but they do not belong to the Sierra belt.

The groups of deposits in northern Plumas County comprise the important discovered ones of the large northern section of the belt above the terminus of the recognized Foothill Belt in Nevada County. In the regions of Indian and Genesee valleys are extensive gossan-capped vein formations, carrying copper, gold, and silver, and some of them considerably prospected. They are in the Sierra gold belt and adjacent to producing gold districts. All carry sulphides at a little depth. Distance from railroads has been a severe handicap to their development. A small smelter which operated for a short time on surface oxides and carbonates was built here in an early day, and a little rich ore has since been shipped. For perhaps 50 miles southward through Plumas and then westerly through Sierra County occasional occurrences mark the course of the belt into western Nevada County, where the foothill series of deposits begins.

From this point southward the foothill belt exists as a great fissure system along the base of the range. Its northern end is about 25 miles north of the northern terminus of the Mother Lode in El Dorado County, and it parallels that great lode throughout its length of 125 miles, running from 5 to 20 miles to its west, with an average distance of about 12 miles. The belt runs through the lower western ends of the counties of the slope, but a few miles east of the floor of the valley and

CHALCOPYRITE

through the principal agricultural and horticultural portions of these counties. The climate is that of the populous portion of the central interior of the State. The croppings of the mineral deposits of the belt range in altitude from 300 to 500 feet in Nevada and Placer counties to several hundred, or, in places, 2000 feet in the counties to the southward, reaching still higher altitudes toward the southern end of the belt. The belt is paralleled at 20 to 30 miles by two main railroad lines running through the eastern side of the valley, and it is reached or crossed by several branch lines at different points along its course. Conditions are in general exceptionally favorable to the mining industry.

The belt is quite regularly and continuously traced by surface gossan formations, and thousands of mining claims have been taken up along it, chiefly in early days. A large portion of it, especially in the northern and central parts, is included in patented agricultural lands. Hundreds of mining properties are now held as such, and a number of valuable mines, productive, idle, or in course of development, are strung throughout its course along the base of the slope. From one end to the other copper deposits occur at intervals.

PLUMAS AND SIERRA COUNTIES.

That section of the great copper belt of the Sierras that lies high along the middle slope courses for about 70 miles southward across Plumas and Sierra counties to then turn westward through Nevada County to the lower foothills. At the very northern end of the belt, in upper Plumas County, are some of the notable unworked copper deposits of the State, and this county's copper resources have received attention since early mining days.

Besides presenting a mineralized copper-bearing belt of similar nature and course, these counties have so much in common in the way of geographical, topographical, and geological features that they may be appropriately taken together here. Both lie in the heart of the Sierras, reaching from the

Nevada state line across the crest of the range, and finding their western boundaries high above the foothills that are embraced in all the other mountain counties traversed by this belt. Plumas has a length of 75 miles east and west and an extreme width of 50 miles. Sierra is a much smaller county. The lowest altitude in either county is about 2000 feet, and the main mineral districts lie between 4000 and 7000 feet above the sea. About this region rise some of the higher peaks of the range, and both counties present the rugged surface and scenic grandeur, as well as the abundant forests, streams, and lakes common to the higher slope. Plumas is wholly drained by the Feather River, and Sierra by the Feather and Yuba and their tributaries, and these streams have cut precipitous canyons often 2000 feet deep. A wealth of water power is thus available. Minor portions of the areas of these counties are occupied by small fertile valleys, chiefly in Plumas County. It is in and about Indian and Genesee valleys in northern Plumas County that the main copper deposits are grouped.

Plumas and Sierra are almost exclusively mining counties, and their copper deposits are in the midst of large and promising quartz mining districts. The great auriferous slate belt of the Sierras crosses both counties north and south, presenting a series of quartz veins through a zone in places more than 20 miles wide. The copper belt is characteristically along the western side of the zone, and runs southward through the middle of Plumas County and the western end of Sierra. Both counties have, since early days, been among the great gold-mining counties of the State. Their early placers were very rich and both have shared with Nevada County the past glory and prosperity of hydraulic mining on this slope and the rich rewards of drift mining, since both extensively share the vast auriferous gravels of the system of "dead rivers" of Tertiary times. While both counties have varied mineral riches, gold has been practically the sole mineral product to date. Coal, copper, marble, iron, asbestos, etc., await more favorable economic conditions. Both counties are inviting fields for mining enterprise.

Plumas County is entered from Lassen County at the north over the crest of the Diamond Mountain range, and from this

point there is a rapid descent of 3000 feet in 12 miles, through Lights Canyon, to the north arm of Indian Valley. Along either side of Lights Canyon, a few miles south of the county boundary, are groups of copper claims with promising surface indications, which are strengthened by the indications afforded by numerous shafts, tunnels, and cuts reaching to no great depth. From two groups of claims some ore has been shipped in past years. Lights Canyon opens on the south into Indian Valley, across which, in the region of Taylorville, are other promising copper prospects, slightly developed. Stretching for several miles east of Taylorville into Genesee Valley and its inclosing hills are the prospects comprised in the Genesee district. One of these, formerly the Cosmopolitan, and now the Reward, was discovered in 1862, and in 1863-64, during the copper boom of that period, was equipped with a small open-hearth smelting plant at a cost of $30,000. A few tons of matte were produced and shipped, but, as the surface carbonates and oxides were succeeded at a little depth by sulphides, the process and plant soon proved a failure. The rest of the story of progress is one of claim-holding for forty years, with occasional spurts of small development operations. In many instances the vein formations in which the ores occur are wide and strong, and copper ores of high grade are found carrying good values in gold and silver. The courses of the copper-bearing veins are frequently marked by gossan cappings. The contiguous districts thus described are embraced in an area about 10 miles wide and 15 miles long from north to south, in north-central Plumas County, and only minor occurrences mark the copper belt southward through Plumas and Sierra to Nevada County. There are sporadic deposits east and west of this belt, including northwest Plumas County on a line with the Shasta County belt, but the mineral resources of western Plumas are mainly buried by the great lava sheet, near the edge of which are the chief districts described.

PLUMAS COUNTY DEPOSITS.

Montgomery Group.—About one mile south of Taylorville is the Pettinger mine. Owners, J. D. Williams et al. In this mine the ores are mainly carbonate, with some sulphide. The openings consist of a shaft 60 feet deep, with southerly drift

100 feet long. The vein formation is 6 feet wide. There is some good carbonate ore on the dump. A tunnel 30 feet long, higher up the gulch, shows a vein several feet in thickness and the same class of ore. Other claims higher up the mountain have open cuts on them, which are noticeable mainly because they show heavy gossan cappings. There is also exposed on this mountain a very heavy and almost pure deposit of pyrites, about 40 feet wide, containing a small percentage of copper.

Polar Star.—To the north from the highway leading from Taylorville to Flournoys and up the mountain is the Polar Star mine, owned by Messrs. Cox, Keasy, and Cooksey, and now controlled by J. D. Williams. This mine is five miles southeast from Taylorville. It is opened by a tunnel and an open cut. The tunnel passes through the vein, which is 10 feet thick, and runs some distance ahead in the east wall. The cut is in a body, or vein, of good ore. The ore is peacock, sulphide and carbonate of copper, with considerable red oxide in seams and bunches. The mountain and adjacent country are heavily timbered with pine and fir. Water is plentiful.

Blue Bell Mining Co.—Along the road toward Genesee, about a mile beyond Hosslekuss's, a limestone belt passes through the country in a northeast and southwest direction. At the apex of a hill on this belt are some heavy croppings to get under which the Blue Bell Mining Company, J. J. Sullivan, superintendent, ran a tunnel which has intersected seven veins of importance.

Reward (formerly Cosmopolitan).—Belonging to the Reward and Beckwith group; Messrs. Salinger, Emerick, and Rosenthal, owners. Adjoins the Blue Bell group on the east. The vein is intersected by a tunnel 100 feet below the surface, which is exposed 2 to 6 feet in width. Two tunnels tap the ore body. The upper one is 175 feet long, and the lower one, 900 feet long, reaches a depth of 400 feet below croppings. A shaft 125 feet deep (caved) is on the higher portion of the claim. Ore on the dump appears to be of good grade. The veins lie between granodiorite on the east and limestone on the west. In 1863-64 there was an old smelter at Coppertown, near Hosslekuss's, in which was smelted several hundred tons

of ore from the Cosmopolitan. The product was subsequently sent to Swansea. At the site of this smelter there still remain about 75 tons of ore, such as was then smelted. The facilities for opening up both of the above properties, viz., Blue Bell and Reward groups, are excellent.

The Duncan Mine.—At the north end of Genesee Valley is a group of twelve locations, known as the Duncan mine. They extend from 3500 to 5400 feet altitude, and are situated west of and near to Indian Creek, one mile from its confluence with Red Clover Creek, and half a mile from Flournoys ranch. The locations cover parts of sections 30 and 31, township 26 north, range 12 east, Mount Diablo meridian. The mine is located on a broad, but rugged and exceedingly steep ridge, projecting southward from the main range, and is accessible by means of a short wagon track and trail. The development consists of two tunnels and several cuts along the outcrop of a vein belt. The geological formation at the mine consists of thinly bedded mica schists, standing nearly vertical, alternating with narrow bands of a fine-grained granite. South and west of the mine appears a broad belt of granodiorite or gabbro, which by its bold outcrop becomes very prominent near Flournoys, at the crossing of Indian Creek. Masses of a dark brown garnet rock are found as float along the trail leading up the mountain. The lower tunnel enters at an elevation of 400 feet above Duncan's camp, and crosscuts the mica schist for 144 feet without developing an ore body. At 800 feet elevation the upper tunnel enters the vein belt on the strike of the schist, and for nearly its whole length of 140 feet follows the edge of a sheet or lens of garnet rock impregnated with copper glance, from which some rich copper ores have been obtained. A 30-foot crosscut has been run northerly from the face of the tunnel. At 1300 feet elevation the summit cut has been run 30 feet, parallel with the schist, developing some ore of the same character as that in the upper tunnel. From this cut, as well as the tunnel below, some ore has been shipped to a smelter. Various shallow cuts and pits along the trail show ore in small quantities, both sulphide and carbonates, nearly always in association with garnet rock or with rhodenite, of which occasionally larger bodies occur. Epidote is quite abundant, and often forms veins in the garnet

rock. Crystals of rhodonite in a white feldspar occur as float, and also occasionally black tourmaline. The garnet rock, which appears to be the principal ore carrier, is generally composed of a dark brown lime-iron garnet, with a small amount of epidote, but a light yellow as well as a black variety is also abundant. Most of the garnet rock when not cupriferous carries gold reported in payable quantities, and frequently becomes a high-grade gold ore. When rich in copper glance it also carries both gold and silver. Ore samples from the northernmost location show copper pyrites disseminated in a fine-grained mica schist. Extensive exploration will be required to determine the boundaries of the vein belt at this mine and define the extent of the copper-bearing zone. The owners are A. W. Whitney, of Crescent Mills, and J. B. Duncan and C. H. Hook; post office address, Genesee.

The Shoofly Copper Mine.—The Shoofly deposit occurs partly on a high-grade, gravelly bench on the north bank of Indian Creek, which here has cut its way through a deep and broad gorge surrounded by precipitous mountains rising 2000 feet above the bed of the stream. The twenty-one locations comprising the property are situated in sections 32 and 33, township 26 north, range 9 east, and in sections 3, 4, and 10, township 25 north, range 9 east, and with the Shoofly ranch, patented, on which the first discovery of copper ore was made, extend in a general northwest-southeast direction, parallel with the strike of the underlying schists. The copper ore occurs disseminated in a quartz-schist, with a nearly vertical dip; with clay slates to the west and a series of igneous rocks, chiefly porphyrites to the east. The copper-bearing vein belt is believed to follow the center line of the locations with an average width of 80 feet. Its copper contents, so far as now explored, are given at nearly 2 per cent. The copper ores here noted are generally bornite, with blue and green carbonates, which latter are constantly forming at the surface from a leaching action. The ore occurs in minute sheets and lenses between the much contorted laminations of the schist, which everywhere exhibits the action of compressive forces. In general structure it resembles strikingly that of the copper-bearing schists of Calaveras County. Besides numerous surface cuts, the principal development on the property consists

COPPER CROPPINGS, WILLIAMS CLAIMS, GENESEE, PLUMAS COUNTY.

MOUNTAIN ON WHICH IS LOCATED THE DUNCAN GROUP OF COPPER MINES, GENESEE, PLUMAS COUNTY, NEAR FLOURNOYS.

of a tunnel 80 feet long crosscutting the strata. It enters on the bank of Indian Creek within the boundaries of the Shoofly Ranch. Work on the property is in progress. Owner, G. H. Goodhue; post office address, Quincy.

The Peters Mine.—This mine is situated on the eastern border of the north arm of Indian Valley, at 3600 feet altitude. and is located in the southwest quarter of section 7, township 26 north, range 11 east, Mount Diablo meridian. It lies at the foot of the Indian Range. The ledge runs from 5 to 15 feet, and has a well-defined hanging wall formed by a fault plane. Its strike averages north 33 degrees west, south 33 degrees east, with a dip of 50 degrees to the southwest. The geological formation at Peters mine is chiefly felsite and felsitic porphyry, occasionally becoming schistose; overlaid to the east by a red metamorphic schist, probably of igneous origin. The ledge is evidently an impregnation deposit, with the strongest mineralization next to the hanging wall. Above the water level its original sulphides of iron and copper are largely oxidized and the copper leached out, while the manganese silicate which abounds has originated various oxides, chiefly pyrolusite. Gold forms the principal value above the water level, with from 2 to 3 per cent of copper, as bornite, copper glance and some carbonates of copper. The gold values often run high and so far have alone been the object of development. The mine has been worked intermittently as a gold mine ever since 1867. The old mine openings have caved long ago. The developments during later years consist of two tunnels crosscutting the ledge, with various drifts, upraises and winzes, with a total length of 1700 feet. W. T. Peter, owner; post office address, Taylorville.

Little Gem Claim.—Located on Ward Creek, where there is a ledge opened by a shaft. The vein is from 6 to 18 inches in width, and carries reported values of $17.96 gold and 31 ounces silver to the ton, and 12.66 per cent in copper.

Williams Group.—To the west of Flournoys, about one half mile, is a mountain which is covered by mining locations held by J. D. Williams. On this mountain the whole outcrop appears to be heavily mineralized by iron and copper in the form of oxides, carbonates, and sulphides. So little develop-

ment work has been performed that no estimate of the worth of the claims can at the present time be made. It is doubtless the outcrop of an immense mineralized dike.

In Cook's Canyon, south of Moonlight Creek, are two claims, owned by Frank and George Davis, on which there has been little development. The vein is 12 to 13 feet wide, and shows carbonate and sulphide ores of good appearance. It has been explored for 800 feet in length by cuts.

Engle Copper Mining Co.—This company, consisting of Messrs. E. V. Spencer, Engle, and Adams, owns two claims on Moonlight Creek, in Lights Canyon, where a tunnel about 100 feet long shows a vein of sulphide, and an open cut exposes the same character of ore.

W. P. Boyden has a claim on Enterprise Creek, from which he shipped ore reported to have yielded 18 per cent copper and 57 ounces silver to the ton.

Engle Bros. have two claims on the west side of Lights Canyon, in section 18, township 27 north, range 11 east, where a mineralized vein about 30 feet wide, carrying sulphides, is shown. It is opened by a tunnel 120 feet long and a shaft 20 feet deep.

On the east side of Lights Canyon, above the residence of the Engle Bros., are two claims, Superior No. 1 and Superior No. 2, where openings were made in years past, and ore was extracted and shipped. There is an open cut 80 feet long, leading into a pit 20 feet wide by 15 to 20 feet high, with a water-filled shaft in bottom of pit said to be 60 feet deep. From this pit some samples of very good ore were taken. This ore contains a high percentage of zinc.

Engle Bros. Group.—This group of eight claims is in sections 3, 9, and 4, township 27 north, range 11 east. The copper deposit is about 300 feet wide and about 1000 feet long. The ores nearer the surface are mostly carbonates, mixed with iron oxide and copper sulphides. The copper belt here is about 1800 feet wide. Reported assays are 10 per cent copper, and from $2.50 upward in gold. The ore body dips to the west and the strike of the vein is northeast. The openings consist of three tunnels and a shaft. Tunnel No. 1 is 100 feet long, and a crosscut at the end exposes 13 feet of carbonate ore. The vein

on which this tunnel runs is 100 feet wide, and the end of the tunnel is 65 feet below the croppings. Tunnel No. 2 is 325 feet long, with crosscut at end which shows a width of 45 feet of sulphide ore 110 feet below the croppings. Tunnel No. 3 (lowest) is 100 feet long, with crosscut at end showing 87 feet of ore and 20 feet of intermediate vein filling. The ore is carbonate, and is 200 feet below croppings. Open cuts on the surface show ore. Considerable ore has been extracted from these mines and sold. The facilities for mining here are good, and there are exceptional tunnel privileges. Heavy growths of pine and fir on the locations and surrounding country furnish abundant mining timber. All the properties included in the Engels groups, named herewith, are now owned by the **Engels Copper Mining Company of California,** office 30 Liberty street, San Francisco, Cal. They are divided into two groups:

The Engels group, situated twelve miles north of Taylorville at 5000 feet elevation, has a strong gossan outcrop 200 feet wide, between a porphyry foot and a diorite hanging wall, of which 6000 feet are covered by four claims located end to end. The following samples are taken from assays reported:

Copper	6.03%	39.40%	25.13%
Gold	$0.41	$1.08	$73.06
Silver	$1.08	$10.98	$3.64

The Superior group is located a few miles southwest of the former, in section 17, township 27 north, range 11 east, on Lights Creek, near the road from Indian Valley to Susanville, Lassen County. The formation is the same as in the Engels group, width of lode between diorite and porphyry 200 feet, strike east of north and west of south, dip 65 degrees east. A new tunnel has been started and seams of ore are reported to come in at 200 feet. It is expected that the Western Pacific Railroad, whose main line runs within twelve miles of the property, will soon be completed. Assays reported:

Copper	4.45%	14.20%	17.38%	24.52%
Gold	$0.41	$0.82	$1.00	.....
Silver	$0.56	$4.20	$5.04	$7.14

It is also reported that analysis of the ores from the various claims showed the mixture to be well adapted for smelting.

Hussleman & Shaw Group.—This group, in Moonlight Creek district, Lights Canyon, comprises thirty-one locations, on nearly all of which some development has been done. A tunnel has been started well down on the mountain side, so as to obtain 800 to 1000 feet of depth under the heaviest croppings. This is a crosscut tunnel and is now in 150 feet. The mountain side here is very abrupt. Passing through these claims is also a highly mineralized belt, which contains masses of high-grade ore.

On the Mammoth claim of the above group the vein trends northeast and southwest. Several open cuts show sulphide ore as well as carbonates. A capping of diorite covers a vein about 8 feet wide, as shown in the largest cut. The capping lies flat and the vein is perpendicular. There is a crosscut on the vein 10 feet in length, with no wall discovered. A good quality of iron and copper pyrites is shown in face of cut. The same class of ore is traced northerly by cuts for 900 feet.

On the Orient claim a tunnel has been driven 150 feet.

On the mountain side and following the course of the proposed tunnel twelve ledges are encountered, all exposed by open cuts. The widest vein is found near the apex of the hill and is about 13 feet wide. It is opened by an extensive cut, and from it ore has been extracted and shipped. The character of the ore is carbonate with some sulphide. The Gentle Annie claim is prospected with open cuts showing a vein 6 to 8 feet in width. The ore is mostly silicious carrying red oxide, carbonates, and pyrites, and can be traced for over 800 feet. Claims Nos. 1 and 2 have a shaft 13 feet deep, showing peacock copper ore in the bottom. Near by is a belt exposing on the surface iron oxides. The width of the copper vein is unknown. Assays from these claims are reported as showing from 10 to 60 per cent copper.

On the Oregon claim at the east end there is a shaft 13 feet deep, all in green and blue-stained ore, said to contain 20 per cent of copper and rich in gold. Some copper glance is also visible in this ore. There are three cuts on this vein, besides a shaft, all showing same varieties of ore. The strike of the vein is south of west. The north wall is diabase, the south diorite. The west end of the Oregon is opened by a superficial cut, which discloses some good carbonate and silicious ore that

is reported to assay 48 per cent copper and $14 in gold, with 15 ounces of silver. A vein parallel with the main one just described also shows good ore. The veins are wide, but the width, owing to lack of development, can not be determined.

On the Olympian claim a vein outcrops and is exposed 30 feet in width of carbonate ore, in an open cut. Lower down the hillside a tunnel was started to obtain 50 feet of backs under the croppings. The tunnel is 85 feet long and cuts 30 feet of gray carbonate ore. The inclosing rock is a diabase, spotted with coarse crystals of feldspar. On the No Wonder claim at the apex of the hill above the Orient tunnel is a vein of green carbonate ore 8 feet wide. There is an open cut 20 feet long and opening on the vein. There are about 100 tons of ore on the dump. In this ore can be seen some copper glance.

On the south hillside is the Palisades tunnel, which was driven to cut a ledge which crops 12 feet in width above it. This tunnel has a length of 197 feet, but has not reached the ledge aimed at, although it has cut several small veins. On the Iowa claim there are bold croppings carrying some copper and said to be very good in gold values.

The Hussleman & Shaw group is owned by Messrs. Hussleman, Shaw, McIntosh, and Williams, and consists of thirty-one mining claims.

The Mammoth claim is owned by Messrs. Hussleman & Shaw, and comprises twenty-nine mining locations.

Broadly, it may be stated, that iron predominates in both the Moonlight district and the Genesee district mineral deposits. Accompanying this pervading iron are copper, gold, and silver.

In section 28, township 26 north, range 8 east, unsurveyed land, two and a half miles south of Meadow View, on the south face of the mountain facing the North Fork of Feather River, there occurs a deposit of sulphide carrying some copper of unknown value and extent. Two tunnels have been started, one above the other. The upper tunnel does not reach the deposit or vein, and discloses nothing. The lower one reaches the sulphide ore. A shaft higher up on the hill was sunk years ago.

Still farther south, just below the Bamboo Bridge, is a formation, copper stained, which may prove to be the outcrop of a deposit of iron sulphides carrying copper.

A few minor copper deposits have been noted in the northwestern part of the county, and there are a few other localities where copper-stained rocks are known to exist, as near Mohawk, and in section 16, township 23 north, range 11 east, but none of these occurrences have assumed importance.

SIERRA COUNTY DEPOSITS.

In the Poker Flat district, in township 21 north, range 10 east, John B. Lassiad owns a claim showing a copper deposit about 60 feet wide, carrying pyrites, oxides, and carbonate of copper.

Bassett's Pride Claim.—About five miles east of Sierra City. Some native copper shows in the deposit, in which a tunnel has been driven. This mine is in section 12, township 20 north, range 12 east, and is owned by Albert Church et al.

Near Sierra City, in section 19, township 20 north, range 12 east, east of Whitney Camp and northwest of the Buttes Rock, there is a copper mine owned by George Zuver. There is a shaft 40 feet deep from which copper sulphides have been extracted and shipped.

The Antelope Neck mines, in section 27, township 21 north, range 15 east, show a wide vein of copper sulphide. Mr. Beamer is the owner.

In Mohawk Valley near the Bullion claim is a prospect showing veins 15 feet in width carrying oxide, sulphide, and carbonate ores of copper. The owners are J. H. Hapgood and J. J. Miller.

NEVADA COUNTY.

Nevada, the banner gold-producing county of the State, with a record of about $215,000,000 in total output of this precious metal, presents some noteworthy copper deposits among the various minor features of its mineral wealth. This county, which still leads in gold production, is so prominently identified with the history of gold mining in California that it is more familiar to the mining world than any of its sister mining counties. Quartz mining in California began in Nevada

County in 1850 and here was the origin of hydraulic and drift mining. The copper mine at Spenceville, which has been a small producer through many years, gives the county a somewhat prominent identification with the story of the copper industry in the State.

This county comprises a narrow strip of mountain and foothill reaching across the Sierras 75 miles to the edge of the Sacramento Valley, where the altitude is but about 400 feet. Its central and eastern parts are characteristically Sierran. The higher lakes and the Bear and Yuba rivers, between which the county mainly lies, afford, in connection with many tributary streams and with great systems of canals and ditches aggregating hundreds of miles, a copious and well-distributed water-supply. Electric power is also extensively generated and distributed. The Central Pacific Railroad runs along its southern boundary and a branch line runs to Grass Valley and Nevada City, affording convenient transportation to a rich and well-populated mining and horticultural region that enjoys a splendid climate.

The county's mineral resources are chiefly near its lower western end. Here, about 15 miles from its western boundary, are the remarkable and famous gold quartz districts of Grass Valley and Nevada City. Through this region and extending to the central part are displayed the ancient river channels which have afforded such extensive hydraulic and drift mining operations, and over the same area are distributed the minor quartz mines of the county, which is traversed by three main auriferous belts. A little west of the Grass Valley gold belt an iron belt crosses the county, and west of this comes the copper belt. From Sierra County it swings southwesterly along the northwestern boundary of the county for perhaps 25 miles, and then turns southward with the direct western boundary line, which it parallels at a distance of from two to four miles along an eighteen-mile course into Placer County. Along the entire course of the belt copper indications occur at intervals, but the chief known deposits are at two points—at Spenceville in the southwestern corner of the county, and about Mineral Hill, three miles to the north, where various properties exhibiting strong veins are being actively prospected, and from where shipments of ore have been made at various times.

There are here many strong copper-bearing veins, and the somewhat extensive developments that have been made give promise of profitable and long-continued copper mining here, under favorable market conditions. The mine at Spenceville has produced nearly a million dollars' worth of copper, iron pyrites, and mineral paint, and from above a depth of 150 feet.

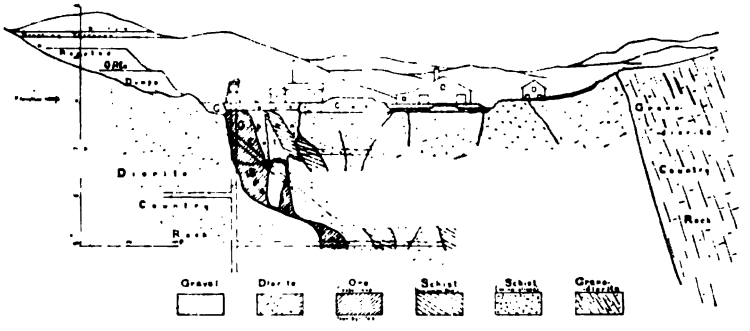
An east and west copper belt in this county is located in the foothills. Pine Hill and French Corral seem from development to be on the east belt, while Spenceville and Mineral Hill are on the west belt. Along the line of strikes on these belts are a number of croppings, showing copper, some of which may prove to be worth developing.

Another copper belt shows at Meadow Lake and Cisco. Some good ore has been found here. This is the west belt in the Sierra Nevada. A belt to the east of the Sierra Nevada is reported near the east line of California. Some very good float has been found, but as yet no discoveries of any great importance have been made.

Spenceville Copper Mine.—This old property has experienced a longer period of operations than any other copper mine in the State, having been worked almost continuously since 1875. Although its operations have never been on a very large scale, both the mine and its history have some features of special interest. The mine has produced quite a large amount of copper, and it was the first mine in the State whose product of pyrites was used for the manufacture of both mineral paint and sulphuric acid. It has been the scene of a number of metallurgical experiments. It is located in the town of Spenceville, in the southwestern corner of the county, at an altitude of 450 feet, and is now owned and operated by the Spence Mineral Company of San Francisco. The ore occurs in a series of wide irregular fissures near the contact of two large areas of country rock (diorite and granodiorite), the fissures being filled with sulphide ores carrying copper, gold, and silver. Mining has been confined almost entirely to that ore, which occurred in the main foot wall fissure in the form of chalcopyrite and iron pyrite, being a continuous vein 300 feet long, and 15 to 55 feet wide. This vein yielded 150,000 tons of ore, the copper content varying from 2 to 20 per cent, the greater part averaging about 5 per cent. By the crude

method of roasting and leaching only about 4 per cent of this ore, or 6000 tons, was recovered as copper, the gold and silver, which averaged from $3.50 to $4.50 per ton, being lost. Parallel and cross fissures on the hanging wall side of this main ledge are filled with strongly mineralized schists and altered diabase, too low in sulphur to be burned and requiring a different method of treatment, but indicating a wide area of mineralization having possibilities in depth.

The San Francisco Copper Company pursued active operations for thirteen years succeeding 1875. The mine was opened by shafts and drifts to about 150 feet in depth, and then, after the works had caved in, mining was pursued in an open cut which became 300 feet long, 70 feet wide, and 75 feet deep.



Ideal Cross Section of Spenceville Formation

Most of the ore taken from the mine, approximately 150,000 tons, carrying an average of 5 per cent of copper, was extracted by this company prior to cessation of operations in 1888, and the sale of the property in 1890, owing to the fall in the price of copper. This company made some costly and unsuccessful smelting experiments, and produced some matte and ingot copper. Most of the output, however, was cement copper, produced by heap roasting and leaching, this company being among the first in this country to introduce and successfully operate by this method. During the year 1882 the company mined over 16,000 tons of ore averaging 4 per cent in copper, and 966,061 pounds of cement averaging 83 per cent in copper, which was shipped to Boston. There was roasted 12,300 tons of ore, yielding a net profit of $2 per ton at current prices. During the year 1882 the cost of production was 9.4 cents

per pound of fine copper. The water from the mine workings was also run through precipitating sluices. The price of copper cement fell in 1887, and operations ceased.

In 1890 the Imperial Paint and Copper Company acquired the property for the purpose of utilizing the old dumps of roasted ore. They erected a paint mill and calcining furnace and manufactured red metallic paint from the iron oxide, which constitutes approximately 40 per cent of these dumps. They also leached the dumps and utilized the mine waters in

PLANT OF THE SPENCE MINERAL COMPANY, SPENCEVILLE.

making cement copper. The company did no mining. The paint manufactured was of exceptional quality, and had a ready sale at the market price of standard paints.

In 1897, the Spence Mineral Company acquired the property and introduced into California a new method of manufacturing sulphuric acid by substituting pyrites as a source of sulphur for the crude sulphur imported from Japan. This proved thoroughly successful and has revolutionized the methods of acid-making on this coast. The mine was unwatered and reopened and large bodies of low-grade pyrites left in the old

works were shipped to manufacturers of acid on the bay of San Francisco at a good profit, the cinders being returnable to the company. These ores proved to be well adapted to this purpose, owing to the absence of arsenic and other injurious elements, and to their free-burning quality, yielding up their 45 to 50 per cent of sulphur without the least tendency to clinker, and retaining the smallest percentage of sulphur in their cinders. The copper contained in these cinders, amounting to from 3 to 3½ per cent, together with the gold and silver, and the iron which has a value as a flux, netted the company from $2 to $3 per ton when subsequently sold to smelters. A successful leaching plant has been constructed by the company on the bay of San Francisco, where its cinders are leached and cement copper manufactured.

At the present writing the company has under way the thorough development and exploitation of its mine below the 150-foot level, and throughout its mineralized area above described, and has under consideration the future treatment of its ores by more modern and efficient methods. Charles W. Howard, Spenceville, is general manager and superintendent.

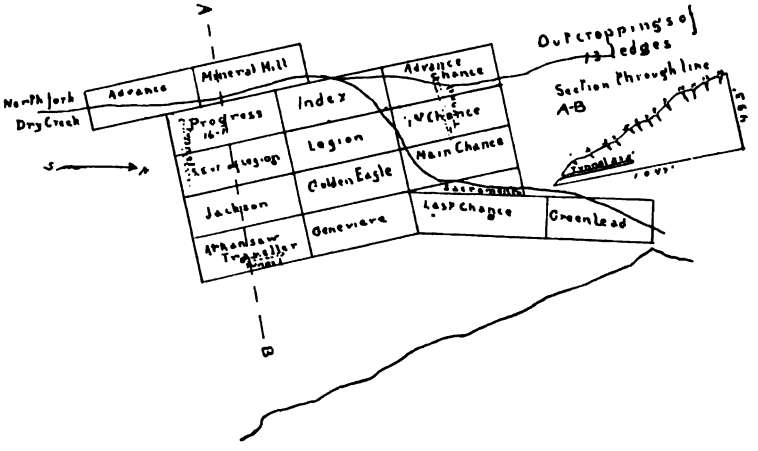
Between Spenceville and the Placer County line to the south there are several prospect holes sunk on the mineral belt, showing the same character of copper mineralization as at Spenceville. On the Nickerson ranch, in section 29, township 14 north, range 8 east, by Wolf Creek, there are exposed two large ledges carrying almost pure pyrites and some gold. Tests of ore from dumps show a copper content of 4 per cent. There is a crosscut tunnel 200 feet in length, which taps the ledge. Croppings are visible for about 800 feet along the ledge. Very little development, however, has been done. The owner is J. R. Nickerson, residing on the property.

Many of the prospect holes before mentioned were made in early days, since which time the lands have been patented and prospecting stopped. This is true also of the territory lying north of Spenceville.

At the Henry Hibber mine, in section 32, township 14 north, range 7 east, seven and a half miles southeast from Spenceville, there are croppings of gossan 3 feet wide and over 400 feet in length. The vein here dips west. The east wall is diorite; the west, schistose diabase. When inspected

the owner had reached copper ore in a vein 2 feet wide, carrying from 9 to 41 per cent of copper, with some gold. The Bear River runs through the property.

Mineral Hill Mines.—About two miles north of Spenceville is located the Mineral Hill group of mines, which have been quite actively prospected. The Mineral Hill Mining and Smelting Company, of which C. C. Bitner is superintendent, owns five claims on the copper belt lying in section 13, township 15 north, range 6 east—the Golden Eagle, Index, Legion, Mineral Hill, and Progress. The California Gold



SKETCH MAP OF MINERAL HILL GROUP OF MINES.

and Copper Company, C. C. Bitner, superintendent, owns six claims—the Jackson, San Francisco, American, St. Louis, Philadelphia, and Sixteen-to-One. The Sacramento, Main Chance, First Chance, and Advance Chance are owned by C. C. Bitner. The Arkansaw Traveler is owned by Jackson & Monasco. The Last Chance, a patented mine, is owned by F. Miller and E. A. Roberts of Sacramento. The Green Lead is owned by the heirs of Thomas Mooney, residing in Smartsville, Yuba County. The Monmouth and Climax claims are owned by J. F. Dempsey of Smartsville.

Bitner & Austin ran a crosscut tunnel through the Advance Chance, First Chance, Main Chance, and Sacramento claims easterly from the ravine, expecting to intersect thirteen ledges

with this tunnel, as that number outcrop on the hillside. The course of this vein is east of north. The thirteen parallel veins vary from 5 to 30 feet in width on the outcrops. All of them show chalcopyrites. A shaft near the hilltop follows the 100-foot vein pitching to the east, which shows some very good red oxide, carbonate, and sulphide ores. The formation that incloses the mineral is a hard diabase.

The Last Chance is opened by a shaft 240 feet deep, with steam hoisting works. The vein is 5 to 8 feet wide, carrying pyrites and chalcopyrites in considerable quantities. Some good ore now lies on the dump. There was considerable ore shipped from this mine as long ago as 1876. The pyrite occurs in this mine, as well as in all others in the district, in lens-shaped bodies, the inclosing formation being a hard, dark-blue diabase.

East of the Last Chance is a series of diorite and quartz ledges, wide and of low grade, of which little is known. They vary from 3 to 100 feet in thickness. One ledge exposed on the hill, and owned by the First National Bank of San Francisco, is fully 100 feet wide and is traceable for over two miles. These ledges occur in succession until the east granodiorite wall is reached.

The Green Lead was worked some years ago, and appears to have a large deposit of good ore. It is in section 12, township 15 north, range 6 east, and is opened by two shafts each about 160 feet deep. The ores are peacock copper (bornite), chalcopyrites, and red oxide, mixed with quartz. Formation same as Last Chance. Ore has been shipped to San Francisco at various times.

The Golden Eagle is opened by a shaft 15 feet deep, showing a 4-foot vein of sulphide of copper and iron. At the north end line, on a vein west of and parallel with the Last Chance vein, is a shaft, inclined to the east, 150 feet deep. To the east of these veins is a tunnel 70 feet long, driven on another vein 300 feet, and at its end is a crosscut to the west ledge. This vein carries the same apparent variety and grade of ore, having some gold content. A considerable amount of carbonate ore shipped from this mine is said to have had a value of $12.50 gold per ton and 10 per cent of copper.

In the Sixteen-to-One mine, a shaft has been sunk in a

20-foot vein. At the time of inspection it was 30 feet deep, all in ore. The ore appears to be of the same general character as in the other mines of the Mineral Hill group, is in quartz and diabase gangue matter, and carries from 7 to 14 per cent of copper.

In the Jackson mine, the improvements consist of a 450-foot tunnel on the ledge, started near the south end of the claim. A body of ore was passed through near the mouth of the tunnel. Most of this ore body was extracted and shipped. It is said to have yielded 8 per cent of copper and $10 in gold. The vein is from 6 inches to 7 feet in width. There are croppings beyond the breast of tunnel, 60 feet wide. There is also a shaft 50 feet deep, in ore.

The Arkansaw Traveler has a tunnel 12 feet long showing a vein of ore 3 feet wide. Ore yielding 5 per cent of copper and $7 in gold has been shipped.

The Genevieve is owned by C. C. Bitner and F. B. Yerby.

The Progress mine has a shaft 30 feet deep, and shows sulphide ore similar to that of the mines of the district.

The Monmouth and Climax claims have a tunnel 460 feet long intended to tap a ledge, and two shafts, one 30 feet and one 50 feet deep, on different veins about 100 feet apart. The ores are light-colored sulphides, which carry 3 to 4 per cent of copper and some gold.

There are gossan outcrops in various places on Mineral Hill, especially on the south end of the Advance and First Chance claims. All ore shoots pitch to the north. All the veins passing through the hill appear to belong to a lode lying to the east of the Spenceville lodes. C. C. Bitner produced and marketed cement copper in 1880 from the Golden Eagle ores.

The California Gold and Copper Company have been driving a long tunnel to obtain several hundred feet of backs in its claims.

The Mineral Hill Mining and Smelting Company has also been driving a deep tunnel to obtain 500 feet of depth under the best of its claims. This tunnel cut three very promising ledges.

The facilities for working any group of the mines mentioned are excellent. An abundance of heavy pine timber stands on the claims, and covers the adjoining country. The

abruptness of the hills makes tunnel mining possible for many years to come. Water for power could be obtained from the Excelsior Water Company, one of whose ditches passes along the top of the hill.

Ledges of copper-bearing rocks not greatly prospected appear in places along the belt to the north county line at Yuba River. From the Green Lead going north, the belt appears to swing to the east and passes through the east half of section 1, township 15 north, range 6 east, and section 6, township 15 north, range 7 east, by the old Hartley house. It thence makes to the north through section 31, township 16 north, range 7 east, and then through sections 31 and 19, township 16 north, range 7 east, to the Yuba River. There are no extensive workings on this section of the belt; croppings and shallow holes indicate the course of the belt, which follows closely the granodiorite formation.

On the road from Smartsville to Grass Valley copper croppings may be seen on the Finie ranch and on the Campbell ranch. Croppings occur also one mile south of the J. Fennimore ranch. Here the vein matter is about 40 feet wide, but not prospected.

Toward the south and southeast of Mineral Hill, the copper belt passes through the Bingers ranch, about four miles south of Mineral Hill, where there are strong croppings. Springs on this property are very strongly impregnated with copper.

Near French Corral, in township 17 north, range 7 east, there is a large deposit of pyrites carrying chalcopyrites. Daniel Roberts, owner.

Near Sweetland, in township 17 north, range 8 east, is an unexplored copper vein.

In Washington Township, section 8, township 18 north, range 11 east, is a vein 6 feet wide, carrying copper, but little developed. E. T. Worthley, owner.

Near North Bloomfield, in section 6, township 17 north, range 10 east, is a claim called the Edison Copper Mine; Wm. Mobley, owner. It is opened by a shaft 45 feet deep, following the vein. The hanging wall is a schistose diabase; the foot wall is serpentine. The vein averages about 13 feet in width in the bottom of the shaft, where some drifting has been done. It is reported to carry 3½ per cent of copper and $3.25

in gold. There is also a tunnel driven 240 feet. At the face of the tunnel drifts have been run on the vein 25 and 15 feet in length, respectively.

Bitner Mine.—In section 13, township 15 north, range 6 east, Mount Diablo meridian, three miles north of Spenceville; owner, C. C. Bitner, Spenceville, California. Area, 160 acres (locations). Elevation, 620 feet. Development, 3 adits 1250, 50, and 450 feet, respectively. There are 4 shafts of 150, 30, 20, and 50 feet, all vertical. Railway, seventeen miles to Wheatland, on Southern Pacific Railroad.

Big Bend, French Corral; located in sections 25 and 36, township 17 north, range 7 east, Mount Diablo meridian; owner, A. F. McPherson, French Corral. Area, 60 acres (locations). Development, 18-foot adit. Formation, schist. Gossan, iron-stained schist, 120 feet wide in places on surface. Values, copper, gold, and silver. Railway, fifteen miles southeast to Grass Valley; Nevada County Railroad. Good mountain wagon road.

Oro Grande Group.—Located in section 27, township 18 north, range 13 east, Mount Diablo meridian. J. P. Clark and F. J. Cook, Cisco, owners. Elevation, 7350 feet. Area, 80 acres (locations); strike, north 85 degrees west; dip of vein, 72 degrees 15 minutes south. Walls, porphyry; vein, 8 to 50 feet. Gossan, iron-stained porphyry. Ore, chalcopyrite, bornite, malachite, pyrite, quartz. Values reported, copper 5 per cent, gold $7, silver 3 ounces. Development, No. 1 vertical shaft 32 feet; No. 2, 3-compartment vertical shaft 125 feet, partly filled; No. 3, 2-compartment shaft, vertical, 105 feet, caved full; 200 feet of open cuts; 30 feet adit on vein; 200 parallel veins showing in places; croppings for 4500 feet. One man working on assessment. Equipment, 1 4-stamp mill. Was worked as free milling forty-five years ago. Sulphide zone reached. Oxides are from 1 to 10 feet in depth. Cisco, nine miles south, is the nearest railway point. Fair mountain wagon road.

Pine Hill Mining Company.—Located in section 12, township 12 north, range 7 east, Mount Diablo meridian; Pine Hill Mining Company, Wolf post office, owners; J. A. Robles, super-

intendent. Area, 160 acres; elevation, 1750 feet; dip of vein, 62 degrees east; strike, north 3 degrees west of formation; shear zone north 50 degrees west. Geology, quartz porphyry, rhyolite. Foot wall, diabase; hanging wall, serpentine. Vein matter 27 feet wide. Development, main shaft, vertical, two-compartment, 200 feet; other shafts and inclines, 200 feet; drifts, 1100 feet. Equipment, 10-stamp mill, 1000-pound stamps; 3 vanners, amalgamation plates; full equipment for free milling ore; blacksmith shop; 2 drill compressors; 8-horsepower geared hoist; boarding house; bunk house; mill building, assay office; office building; 2 pumps. Power, steam, 85-horsepower. Ore, gold, copper, silver, chalcopyrite, malachite, red oxide, bornite, native copper, in clay; quartz, pyrite, iron oxide. Fine white kaolin, 150 feet wide; some barite. Gossan, iron-stained porphyry and rhyolite; limonite, hematite. Has been worked as a gold mine. Water from adit running through sluices precipitates some cement, copper and iron. Nearest railway, Auburn.

Red Ledge Mine.—Located in section 36, township 17 north, range 7 east, Mount Diablo meridian; owners, A. F. McPherson et al., French Corral. Area, 160 acres (locations); elevation, 1220 feet; dip of vein, 60 degrees west; strike, north 45 degrees west; walls, schist. Development, 6 adits; No. 3, 110 feet in length, 7 feet of ore; No. 2, 167 feet in length, 27 feet of ore; No. 6, 330 feet in length, 16 feet of ore; Nos. 1 and 4 caved, old work; Nos. 2 and 3, about 100 feet above No. 6. Ore, gold, silver, copper, malachite, chalcopyrite, iron pyrites, quartz. Gossan, iron-stained schist, about 500 feet wide in places. Equipment, 10-stamp mill, 1000-pound stamps; water power, impulse wheel; cyanide plant. Worked as gold mine for some years. Railway, fifteen miles southeast to Grass Valley.

Red Mountain Group, Cisco; located in section 17, township 17 north, range 13 east, Mount Diablo meridian; owners, Red Mountain Copper-Gold Mining Company, J. A. Wilcox, manager, Cisco, California. Area, 640 acres (locations); walls, schist and slate. Ore, copper, gold, and silver. Values reported, gold $15.50, copper 4½ per cent, silver 1 ounce; average from car lots. Development, adit 30 feet in length. Railway, three and a half miles to Cisco.

Sweet Ranch.—Located in section 13, township 14 north, range 7 east, Mount Diablo meridian; owner, John Sweet, Wolf post office. Elevation, 1800 feet. Area, 210 acres. Strike of vein, north; dip, east. Gossan, iron-stained rhyolite and porphyry, hematite, limonite. Development, two or three 10-foot holes. Values reported, croppings, $1.50 to $12 gold and silver. A part of Pine Hill. Breccia shown south side of hill, some barite on top. Nearest railway point, fourteen miles south to Auburn.

Tola Group, Cisco; located in section 27, township 18 north, range 13 east, Mount Diablo meridian; owners, E. E. Wyman et al. Area, 60 acres. Dip of vein, 49 degrees south; strike, 82 degrees west; vein, 4 feet; walls, porphyry; elevation, 7150 feet. Gossan, iron-stained porphyry. Ore, chalcopyrite, pyrite, malachite. Values reported, 15 to 18 tons shipped in 1906 averaged $28 per ton in gold, silver, and copper. Development, open cut, 50 feet; 12-foot adit; 3 to 10-foot holes. Equipment, bunk and boarding house and barn. Road, eight miles to Cisco, on Southern Pacific, over a fair mountain road.

Turner Group, Cisco post office; located in section 16, township 18 north, range 13 east, Mount Diablo meridian; owner, W. M. Turner, Webber Lake, Sierra County. Area, 120 acres (locations); strike of vein, northwest; dip, south; vein 16 feet at shaft. Gossan, iron-stained porphyry; walls, porphyry. Development, 18-foot shaft; some cuts. Ore, chalcopyrite, pyrite; values reported, gold $9, silver 5 ounces, copper 4 per cent. Good wagon road to Truckee, thirty-three miles southeast; ten miles fair road to Cisco.

Wetteran Ranch, Spenceville post office; located in section 34, township 15 north, range 7 east, Mount Diablo meridian; owner, G. G. Wetteran, Grass Valley, R. F. D., Box 62. Area, 540 acres. Elevation, 900 feet. Railway, ten miles northeast, to Grass Valley. Development, 20-foot vertical shaft, open cuts, trenches. Strike of vein, north. Gossan, limonite, iron-stained breccia of rhyolite. Ore, malachite, pyrite. Good wagon road to Grass Valley.

Boss Mine, North San Juan; located in section 12, township 17 north, range 7 east, Mount Diablo meridian; Louis Schloss & Co., San Francisco, owners; J. H. Collier, manager. Rail-

way, fourteen miles southeast to Grass Valley, Nevada County Railroad. Elevation, 2100 feet. Area, not given. Development, 250-foot 2-compartment vertical shaft, 34-foot crosscut at 150-foot level to vein. Power, electric. Equipment, 50-horsepower electric motor; 1 8-drill compressor; 1 2-cylinder geared hoist, air driven; shaft house, power house, blacksmith shop, 6-post head frame. Strike of vein, north; dip, 80 degrees east; walls, schist; ore consists of copper, gold, silver, iron pyrites, iron oxide, chalcopyrite. Oxidized zone about 100 feet deep. Gossan, iron-stained schist 1000 feet wide in places. Vein 2 feet wide at 100-foot level, 12 feet wide at 150-foot level. Worked for gold some years ago.

Carlisle, Cisco post office; located in section 4, township 17 north, range 13 east, Mount Diablo meridian. Area, 260 acres (patent). Elevation, 5600 feet. Strike of vein, southeast and northwest; dip, not given; width of vein, 2 feet to 10 feet; walls, porphyry. Gossan, iron-stained porphyry. Development, adit No. 1, 500 feet, and No. 2, 400 feet; others 400 feet; total, 1300 feet. Ore values reported, copper 7½ per cent, gold $6, silver 4 ounces. Silica, iron, and copper sulphide. Good mountain wagon road, nine miles southeast to Cisco; seven miles southwest trail to Crystal Lake, both on Southern Pacific Railroad. Equipment, aërial tramway 2600 feet; turbine wheel 200-horsepower; sawmill, blacksmith shop, boarding house and bunk house; power, water power.

Fairview Mine.—Located in section 2, township 17 north, range 10 east, Mount Diablo meridian; owners, Fairview Mining Company; C. M. Wilson, superintendent, Relief Hill post office, Nevada County. Area, 160 acres (8 claims, locations). Elevation, 4325 feet. Hanging wall, schist; foot wall, serpentine. Vein, 12 feet in places; dip of vein, 65 degrees 30 minutes west; strike, north 17 degrees west. Gossan, iron-stained schist. Nevada City nearest railway point, twenty-one miles southwest. Development, 375-foot adit in on vein; about 170 feet backs. Ore, chalcopyrite, red oxide of copper, iron pyrite, gold, quartz, iron oxide. Equipment, car, track, and blacksmith shop. Values reported, copper 1.1 per cent, gold $4, silver 16 cents. Open cut on hill was worked for gold by sluicing some years ago.

Gautier Ranch.—Located in section 28, township 14 north, range 8 east, Mount Diablo meridian; owner, William Gautier, Auburn, California. Elevation, 1450 feet. Strike of vein, north 4 degrees west; dip, 80 degrees east; strike, breccia, 1 degree northwest; dip, northeast. Foot wall, schist; hanging wall, schist. Area, 320 acres. Vein, quartz porphyry, with some rhyolite showing. Gossan, iron-stained porphyry and rhyolite, with some limonite 30 feet wide in places. Ore, malachite, chalcopyrite, pyrite, quartz. Development, old shaft, vertical, 80 feet deep.

California Mine.—Owners, California Gold and Copper Company, Spenceville. Strike of vein, north 48 degrees west. Area, 65 acres. Elevation, 560 feet. Dip, 60 degrees northeast. Walls, diorite. Vein, 4 feet wide. Development, main adit, 1000 feet. Drifts, 600 feet on vein. Located in section 12, township 15 north, range 6 east, Mount Diablo meridian, three miles north of Spenceville. Railway, seventeen miles to Wheatland, on Southern Pacific Railroad. Good wagon road. Equipment, blacksmith shop, office. Gossan, limonite and iron-stained diorite. Fifteen men working. Backs, 224 feet above adit level. Values reported, copper 6 per cent, some gold and silver. Ore, malachite, bornite, chalcopyrite, iron pyrite, quartz.

Iron Mountain Mine, Fernley post office; located in section 3, township 15 north, range 7 east, Mount Diablo meridian; owner, Mammoth Mining Company, Kennet, California. Area, 120 acres. Elevation, 1775 feet. Strike of vein, north and south; dip, 70 degrees east; vein, 12 feet wide. Walls, rhyolite. Gossan, limonite and iron-stained rhyolite cropping for half a mile, 300 feet wide in places. Development, 250-foot vertical shaft, 2-compartment; 2300 feet of drifts. Ore, gold, copper, iron oxide, pyrite, malachite reported to contain 33 per cent of sulphur and 67 per cent of iron. Railway ten miles southwest from Grass Valley, the nearest railroad point. Good wagon road. Equipment, shaft house, blacksmith shop, bunk house, geared hoist, 2-cylinder link motion; power, steam, 25-horsepower; 1 horizontal and 1 vertical boiler; pump and horizontal boiler at creek pumping water for steam purposes. Values reported, gold, copper, and silver.

Lotzen Ranch, Grass Valley post office; located in section 2, township 14 north, range 7 east, Mount Diablo meridian; owner, William Lotzen, Grass Valley, California. Area, 158 acres. Railroad, ten miles northeast to Grass Valley. Nearest post office, Wolf, three miles. Elevation, 1050 feet. Foot wall, granodiorite; hanging wall, diorite. Strike of vein, north 30 degrees west; dip, 85 degrees southwest. Vein, 16 feet in width. Development, 60-foot adit crosscut; 16 feet of this is a mineralized diorite, showing chalcopyrite, bornite, pyrite, quartz, red oxide of copper. Appears to be near water level. Gossan, iron-stained diorite and limonite. Good wagon road.

Mammoth Gold Copper Mine, North San Juan post office; located in section 12, township 17 north, range 7 east, Mount Diablo meridian; owner, G. W. Broyles, French Corral. Area, 60 acres (locations). Development, 40-foot adit. Walls, slate; dip of vein, 85 degrees east; strike, north and south. Values reported, copper 2 per cent, gold $3. On main Yuba River, work near river level. Railway, fifteen miles southeast, to Grass Valley. Good wagon road. (Not visited; owner's report.)

Mammoth Group, Cisco post office; located in section 4, township 17 north, range 13 east, Mount Diablo meridian. Area, 80 acres (locations). Strike of vein, northwest; dip, south; walls, porphyry. Gossan, iron-stained porphyry. Development, shaft 285 feet deep, vertical; drifts in ore 75 feet; No. 1 adit, 75 feet; No. 2, 200 feet. Ore, copper, gold, and silver. Values reported, gold $15, copper 4 per cent, silver trace. Good mountain wagon road to Cisco. Equipment, machinery for a 10-stamp mill, not in place. (Owner's report.)

Grizzley Ridge, North Columbia post office; owner, Grizzley Ridge Mining Company, North Columbia post office. Values, gold $40, copper 1¼ per cent, silver 17 ounces. These values are owner's report.

YUBA COUNTY.

To the west of Nevada and also north of its western portion lies the small valley and foothill county of Yuba, which presents a few occurrences of copper ores. These are but a few miles from Nevada County's line of deposits, and may be regarded as belonging to the same belt, flanking it in the manner of so many occurrences that elsewhere mark the varying zone described as the general foothill belt. The principal occurrences are on the Dempsey ranch, five miles north of Spenceville, near the county line, and on the Brady ranch, in the southern portion of the county west of Spenceville and northwest of the chief occurrences in Placer County.

Dempsey Ranch.—Here bold croppings over 400 feet wide, exhibiting gossan croppings, present interesting surface indications of what may be a large copper deposit. Some samples of ore have assayed 35 per cent copper. This prospect is on a productive ranch and has received little intelligent development, the latter consisting of some prospect holes and a tunnel 100 feet long.

Brady Ranch.—On this ranch, in section 1, township 15 north, range 5 east, and in section 35, township 16 north, range 5 east, croppings occur and there is an old abandoned shaft, the water from which is strongly impregnated with copper. Prospect holes trace the belt southeast to Bear River, through sections 21, 22, 27, and 28, township 14 north, range 6 east. On the Brady ranch is what is called the Old Red Ledge, wherein red oxide of copper is visible. This deposit was quite extensively exploited in 1863.

PLACER COUNTY.

Placer, one of the tier of rich mining counties which span the Sierra range, lies south of Nevada County, and in its length of 100 miles it reaches from the angle in the State's eastern boundary down into the Sacramento Valley, possessing

in its foothills a section of the copper belt. Its physical characteristics are those common to its neighbors of the great range, as were the general features of its early mining period. It shared largely in the prosperity of the period of hydraulic mining through the possession of rich and extensive ancient river channels.

Its drift mines now give it its claim to preëminence in one feature of the mining industry. In the Forest Hill Divide, a great spur of the range, reaching westward down the slope for 25 miles, there lies deeply buried under lava cappings the most extensive network of ancient river channels found along the range, and in this divide are the chief drift mines of the world. This divide has yielded over $30,000,000, and the bulk of the total current output of the drift mines of the State is yet credited to Placer County.

A little to its south, in El Dorado County, is what is generally taken to be the northern end of the Mother Lode, and a little to its north, in Nevada County, are the famous Grass Valley and Nevada City mining districts. The great Sierra gold belt crosses the county, presenting innumerable and widely distributed quartz veins, and there are many rich mines, but quartz mining is yet in a relatively backward condition. Granite and pottery are the chief additional features of its mineral industry, in which Placer County holds a leading place. Iron, chrome, manganese, marble, limestone, and mineral waters are among its other mineral resources. Lake Tahoe, at an elevation of over 6000 feet, lumber forests, and a rich horticultural region in the foothills, are among other features of the county. The Central Pacific Railroad traverses the entire length of the county along its northern border.

At various places along an irregular line across the western portion of the county the foothill mineral belt displays copper deposits. A few have been prospected and small amounts of copper ore have been shipped. Some very wide veins are displayed.

There is an east and west belt of copper in this county. The west belt is composed of that along or near granite contact: Dairy Farm, Valley View, Algol, and Eclipse Consolidated. This belt is in places two and a half to three miles wide, *i. e.*, Valley View to Algol.

Gossan and copper stain show in a good many places along this west belt, between the known mines, but is not continuous. Strike, west of north on both belts.

The property of the California Mineral Land Company is on east belt. While the gossan and copper stain can be traced for a good part of the way across the country, it is not continuous, or not so well developed as the west belt.

The east belt in places follows a brecciated zone, with a strike of north about 60 degrees west, but on account of the limited development it can not be stated if it follows this at all times or not.

Eclipse Consolidated.—This mine is located in section 17, township 12 north, range 8 east, Mount Diablo meridian, two miles southwest of Auburn; owners, R. B. Simington, San Francisco, and G. F. Lavalee, Auburn. Area, 100 acres. Strike, north; dip, 22 degrees east at incline shaft. Foot wall, granite; hanging wall, porphyry. Elevation, 1000 feet. Ore, chalcopyrite, malachite, zinc, iron pyrite, gold, silver, quartz, red oxide of copper. Some fair ore on dump. The width of vein could not be determined, shaft full of water. Gossan 100 feet wide in places, shows strong for a quarter of a mile. Development, 100-foot 22-degree incline shaft, single compartment; one 280-foot 60-degree incline shaft, caved full; one 200-foot vertical shaft, caved full; 540 feet drifts. Values reported, 7 per cent copper, gold not given. Worked for gold near surface for some years. Gossan carries gold. Limonite and hematite.

Algol Mine.—This is one of the copper prospects opened in the early sixties and subsequently abandoned. The present owner reopened it. It is in section 9, township 13 north, range 7 east, a few miles southeast of Spenceville, Nevada County. The vein channel is 50 to 60 feet wide. The more highly mineralized portion constituting the ore is from 20 inches to 10 feet in width, the ore occurring in lenses. The length of ore now forming the shoot is 90 feet. There is one shaft 120 feet deep, with a drift running north 100 feet, and another shaft 120 feet deep, with drifts at the 50 and 100-foot levels. A crosscut runs from one shaft for 65 feet to the west. The ores are red oxide and

blue and green copper minerals, besides considerable native copper in sheets and bunches. Native gold also accompanies this deposit. Ten carloads of ore were shipped to a reduction works, which averaged 20 per cent copper. Electric power for mining and reduction purposes can be readily obtained.

On the south of the Algol mine there is a shaft on an extension claim, 80 feet deep. This shows copper ore. Farther to the south, going to Coon Creek, there are five shafts, with depths of about 50 feet each, sunk years ago, and all showing strong copper indications. Farther south, beyond Coon Creek, there is a shaft 40 feet deep, showing some copper. On the Lardner ranch, and on the Keiler ranch, three miles south of Lardner's, there are also strong croppings of copper-bearing rocks.

Valley View Mine.—This property consists of 90 acres patented ground, located in section 24, township 13 north, range 6 east, at an elevation of 610 feet, about six miles from Lincoln, a station on the Southern Pacific Railroad. The lode is 200 feet between walls of schistose rock; strike 60 west; dip 72 northeast, with gossan 100 feet wide that can be traced over 1000 feet along the vein. This gossan carries in gold and silver from $1 to $10 per ton, and is reported to average $4 per ton. The mine was worked for years for the gold in the gossan. The ore varies in width from 5 to over 30 feet, and consists of iron and copper sulphides and oxides, zinc and some native copper in a couple of andesite dikes which occur in the center of the lode. The water from the mine carries copper and passes through precipitating boxes. The shipping ore is reported to carry 10 per cent copper and some value in gold as high as $30. Development consists of three shafts, one 170 feet deep and equipped with a hoist, and 400 feet of adits. Besides there are the necessary buildings, blacksmith shop, etc., and 2 Huntington 5-foot mills. Owner, W. B. Hellings, San Francisco.

Dairy Farm Mining Company.—The Dairy Farm mine is situated nine miles northeast of Sheridan, on the Southern Pacific Railroad, in section 27, township 14 north, range 6 east, Mount Diablo meridian; owners, Dairy Farm Mining Company; office, 71 Broadway, New York; Corey C. Brayton, manager, Van Trent post office. Strike, north 2 degrees west;

dip, 60 degrees east; foot wall, schist and greenstone; hanging wall, greenstone. Ore, iron oxide at surface, some gold and silver. At about 85 feet in depth sulphides begin. Iron pyrite, chalcopyrite. Values reported, copper 3¼ per cent, sulphur 40 per cent, gold $30 in places. Ore is a replacement. Vein, 25 to 50 feet wide. Development, 590-foot 60-degree incline shaft, three compartments; 6000 feet of drifts, cuts, and raises. Equipment, 70-foot 4-post head frame; machine shop; office building; boarding house; cottages; 100-ton cyanide plant for surface ores; compressor; hoist, electric. Power, electric, 750-horsepower. Area, 160 acres.

Thomen Mine.—Located in sections 4 and 5, township 13 north, range 8 east, Mount Diablo meridian; owner, A. Thomen, Auburn, Placer County. Area, 700 acres. Strike, north 5 degrees west; dip, 80 degree east; formation, schist. Ore, chalcopyrite, malachite, iron oxide, iron pyrite. Width of vein not known. Development, 90-foot shaft. Elevation, 1450 feet. The mine is eight miles north of Auburn. There is a good wagon road to Auburn.

Davenport Mine.—Located in section 15, township 12 north, range 8 east, Mount Diablo meridian, about one mile south of Auburn; owner, N. E. Davenport, Auburn. Strike, south 3 degrees east; dip, 80 degrees east. Walls, slate. Ore, quartz, chalcopyrite, malachite, iron oxide, iron pyrite. Vein about 2 feet wide. Development, 70-foot incline shaft, single compartment. Elevation, 1200 feet. Reported values, copper 1 per cent, gold 75 cents. Small hoist. Power, steam, 10-horsepower. Trail to mine.

Nevada Mining Company.—Located in section 32, township 14 north, range 8 east, Mount Diablo meridian. Area, 150 acres in Placer County and 30 acres in Nevada County. L. G. Schuster, manager, Auburn. Strike, north 5 degrees, west; dip, 30 degrees east. In diorite, near slate. Ore, chalcopyrite, malachite, iron oxide and iron pyrite. Width of vein not known. Development, 55 feet; 2-compartment incline shafts. Elevation, 1475 feet. Values, gold, silver, copper. Equipment, blacksmith shop, shaft building, and boarding house. Copper showing in three places, small amount on surface. Railroad eight miles north of Auburn. Good wagon road to Auburn.

Elder Mine.—This mine is located four and a half miles west of Clipper Gap, on Southern Pacific Railroad, in section 4, township 13 north, range 8 east, Mount Diablo meridian; owner, Robert Elder, Auburn. Area, 300 acres in Placer County and 60 acres in Nevada County. Strike, north 5 degrees west; dip, 80 degrees east. Ore, chalcopyrite, malachite, red oxide of copper, iron pyrites, iron oxide; small amount of molybdenite, showing in a granodiorite. Foot wall, probably slate. Width of vein not known. Development, 25-foot vertical shaft in granodiorite. Elevation, 1550 feet. Wagon road to railroad.

Big Pine Mine.—In section 16, township 12 north, range 8 east; J. A. Bouk and C. R. Bushnell, owners. Shaft 170 feet deep, showing chalcopyrite, said to carry 10 to 12 per cent of copper.

EL DORADO COUNTY.

El Dorado County, the scene of Marshall's discovery of gold and the earliest beginning of the modern era of gold mining, includes, through its lower western portion, along the edge of the Sacramento Valley, about 25 miles of the foothill copper belt. Along this line the belt mentioned displays many copper deposits that have been prospected in the superficial way common to the Sierra Nevada array of these deposits. They are but a little north of the section of the belt through Amador and Calaveras counties, in which the chief development and production of this copper belt have occurred.

None of the counties of the slope presents more favorable conditions for mining and none offers a wider or more attractive field for mining enterprise. The chief of the mineral belts that cross the county is the Mother Lode, the northern end of which is near the northern boundary and along which, across the county southward, is a succession of valuable and promising quartz mines. Since the exhaustion of the rich surface placers and the cessation of hydraulic mining, quartz mining is the leading feature of the county's mining industry. There

are many miles of unprospected ancient river channels. The northern and southern boundaries are formed respectively by the Middle Fork of the American and the Cosumnes River, and these streams, with the South Fork of the American and the many tributary streams, bounteously water the county and afford convenient sources of power. The timber resources are those common to the slope. The western portion of the county has a delightful climate, and the foothill mineral belt runs through a rich and settled region. It is crossed by the branch railroad running to Placerville. While gold remains the mineral product of overshadowing importance, the county has other minerals in large variety. Near Placerville is an eight-mile belt of finely laminated slates, in which several slate quarries have been opened. This is the only county in which slate is commercially produced.

While a number of the best developed copper properties display very wide veins carrying ores that often assay well, and continuous gossan cappings of copper-bearing lodes can be traced for miles, no producing mines of importance have been developed. Tunnels and drifts aggregating thousands of feet have been run in the work of prospecting, and several properties have thus been opened sufficiently to indicate values worthy at least of investments necessary for further exploration. Some of the ore bodies carry good values in gold and silver along with good percentages of copper sulphides. The characteristics of both vein matter and walls display much variety. There is every indication of an east and west belt in the foothill section. Lilyama and Pioneer are on the east belt, while the Alabaster is on the west belt.

Another belt might include the Noonday and E. E., east of El Dorado. These two ~~are just~~ at the east line of the Mariposa slate. About three miles north is the Larkin copper mine, on the same belt, as it is along the east edge of the Mother Lode formation. About twelve miles north is the El Dorado Copper Company and other properties, that is, just east of the Mother Lode formation.

Alabaster Cave Mine.—The property is located on 180 acres patented land in sections 10 and 15, township 11 north, range 8 east, elevation 800 feet, five miles from Newcastle station, on the Southern Pacific Railroad; owner, W. Russell, Santa

Cruz, California. A strong, unbroken ledge, 12 to 20 feet wide, between a lime hanging and a slate foot wall, strike north, dip 60 degrees east, can be traced for six miles, showing solid gossan 30 feet wide. The vein matter consists partly of mineralized diabase, and 8 to 10 feet of ore, composed of oxides, malachite, azurite, etc., and some native copper near the surface, and of sulphides, chalcopyrite, bornite, etc., in depth, which are reported to average 3 to 4 per cent copper, with some values of gold and silver. There are three shafts, two of 50 feet and one of 300 feet, and two tunnels, one of 100 and one of 30 feet.

Kelley Bros. own a mine on the 560 acres patented ground in section 10, township 11 north, range 8 east, two miles north of Alabaster Cave mine. The main vein is 40 feet wide. No capping. There is a network of ledges similar to the White Rock country in Mariposa County. The openings are 2000 feet of drifts and tunnels. The ore carries gold, silver, and copper. One ledge is reported to yield ore assaying 5 to 11 per cent of copper.

Lilyama Mine.—In section 3, township 11 north, range 9 east; owners, Robert Crocker & Co., of Placerville. The property consists of 240 acres of patented land. The length of the vein covered by the claim is half a mile; the width, from 600 to 800 feet. Granite forms the east wall, and quartz porphyry the west. Between these lies a band of mineralized limestone, probably pitching to the east. The croppings are gossan and nearly pure black iron oxide (magnetite). The deposits were first slightly opened in the sixties by cuts and short tunnels, which were driven until they encountered the ironstone. When that was reached the prospectors quit, just before encountering the copper ore, for which they were evidently seeking. The later developments were commenced in August, 1889, and were continued about a year. They consist of four main tunnels and one prospect shaft 20 feet deep. The ores are principally sulphides, but there are also other varieties of copper ore. The ore masses occur in lenses in the limestone. The mine is eleven miles from Auburn, Placer County, connected with that place by a good stage road. Elevation, 1050 feet. Strike of vein north, dip west. Ore seems replacement of porphyry, and is reported to average 10 per cent copper, 10 ounces

silver, and $10 in gold. The mine is equipped with all necessary buildings, blacksmith shop, assay office, etc.

Pioneer Mine.—This is an extension of the Lilyama. The vein ore and formation are precisely the same in both mines. It is in section 3, township 11 north, range 9 east. The owner is William Haaker. The vein matter is 50 to 60 feet wide. The vein runs the length of the 80 acres of patented ground. It is opened by a main tunnel 900 feet long with two branches, one of 350 feet and another of 200 feet. There are two shafts, one of 90 feet and one of 100 feet; connected at bottom by a drift 50 feet long. These encounter a good body of ore, which consists of bornite, malachite, copper and iron pyrites, some oxides and some gold and silver. Elevation 1010 feet. Strike of vein north, dip west.

Homestead.—This property, which has been worked for the gold contents of a ledge 14 feet wide, is three miles west of Greenwood at the northern side of the county, and displays ore carrying a considerable percentage of copper. Owner, Mr. McCrary.

Cambrian Mine.—In section 23, township 11 north, range 9 east, about ten miles from Placerville. When first opened in the fifties it was for gold, but latterly the good percentage of copper has brought this mineral into prominence. The present owner is the Cambrian Mining and Milling Company, a corporation, of which F. Thomas is president, Leonard Thomas general manager, and D. R. Roberts superintendent. The company took possession in January, 1898. The width of the three veins passing through the property is from 15½ feet down to an average of 6 to 8 feet. The veins are from 50 to 70 feet apart. The vein matter is talcose schist and lime. The east wall is granodiorite, the west serpentine. Between these are bands of schist and limestone. The croppings are talcose schist and gossans in the schistose rock. All dip to the east. There are three tunnels—one of 113 feet, the second of 220 feet, the third of 1360 feet in length. Also two winzes, each 187 feet below the 1360-foot tunnel. There are over 1350 feet of drifts. The ore is sulphide, green carbonate, red oxide, and native copper, and carries reported values from 8 to 16 per cent copper. The most interesting feature, however, of this ore is

the quantity of gold it carries. The company has shipped several carloads of ore as it came from the vein with no assorting, reported to be 10 per cent copper. The lower tunnel has been extended to 2500 feet.

Cosumnes Copper Mine.—This property lies off the copper belt east of the Mother Lode, in section 25, township 9 north, range 12 east, and was opened in very early times. The vein courses east of north and west of south, and is mineralized limestone and amphibolite schist. The ore is sulphide, green and blue carbonate, oxide, silicate, and peacock, with reported values of over 4 per cent copper. One tunnel, 100 feet long, cuts the vein for 30 feet. A winze is sunk in the tunnel 30 feet, all in ore. Another tunnel, 150 feet long, passes westerly though a light-colored diorite rock to the vein, and then turns and follows its course for 60 feet. Another tunnel runs toward the east for 80 feet through the granite hanging wall. The limestone belt is 500 feet wide. There appears to be no iron capping. The sulphides come to the surface in the limestone. Area, 42 acres patented, 63 acres locations. Elevation, 2010 feet. Distance from Placerville, station on Southern Pacific Railroad, twenty miles. Ore is reported to carry values in gold and silver besides copper. The mine is equipped with water power generated by a 4-foot "impulsive" wheel under 26-foot head, driving a 3-drill compressor and a 2-cylinder 20-horsepower air-driven hoist. Water is carried in a flume one and a quarter miles long. All necessary buildings are on the ground. Owners, Rio Vista Gold and Copper Mining Company, Fairplay, El Dorado County.

Wm. Barklege and S. W. Miller own a claim in section 13, township 12 north, range 10 east, on 140 acres of patented ground. The croppings show a gossan cap 100 feet wide. A tunnel has been driven 118 feet. Elevation, 2610 feet. Strike of ledge, north 25 degrees west; dip, 70 degrees east. Very little development has been done. There are indications of copper. The formation is slate.

Ford Group, Contraband Tunnel.—Area, 60 acres (locations), in section 24, township 12 north, range 10 east, near Georgetown, twenty miles west of Auburn, on the Southern Pacific Railroad. Elevation, 3550 feet. Owners, El Dorado

COSUMNES COPPER MINE, EL DORADO COUNTY.

CONTRABAND TUNNEL, EL DORADO COUNTY.

Copper Company; W. E. Everson, manager. Vein about 12 feet wide between a hanging wall of micaceous schist and a diorite foot wall. Strike, north 80 degrees east; dip, 45 degrees north. Ore, oxides, native copper, enargite, and sulphides, reported to contain as high as 18 per cent of copper in places. Development, several tunnels and a 65-foot incline.

Arizona Claim.—North of the above described tunnel. It has gossan croppings 100 feet wide.

Copper Chief.—Owners, William James and L. A. Beckstead. Lies in township 12 north, range 10 east, two miles east of Georgetown. Gossan croppings 100 to 200 feet wide. Walls serpentine.

Agara Claim.—"Big Jim," a Chinese, owner; one half mile north of the Cosumnes mine, in section 19, township 8 north, range 9 east. Shaft 25 feet deep.

Boston Mine.—This is an old mine about four miles west of Shingle Springs, in section 22, township 9 north, range 9 east. It has a shaft about 400 feet deep. The owners extracted and shipped good ore up to the seventies. Vein matter, schists; ore, sulphides.

Dr. Wren Claim.—In section 7, township 9 north, range 11 east; east of Cilio's ranch, and east of the Mother Lode. Vein matter talcose schist, foot wall porphyry, hanging wall black slate. Vein, 6 feet wide; shaft, 18 feet deep. Several open cuts. Reported values 5 to 18 per cent copper.

Robert Claim.—Owned by W. L. and L. Robert, in section 13, township 9 north, range 11 east. Vein is 3½ feet wide. Formation slate, with a quartz vein on the east side. Foot wall schist, hanging wall slate. Shaft 80 feet deep and a tunnel 150 feet long, tapping ledge. Copper content reported to be from 4 to 24 per cent.

There are several holes between Shingle Springs and Latrobe, where former prospectors searched for copper. The developments are, however, so slight that they serve to indicate the presence of copper ore rather than the extent of it.

The Bryant ranch, in section 2, township 8 north, range 9 east, one and a half miles northwest from Latrobe. Ledge 4 feet wide; shaft 65 feet deep. Idle since 1860. Ore carbon-

ate and gray oxide copper. Owner, "Big Jim," a Chinese, who also owns a property in section 8, township 8 north, range 9 east, five miles north of Copper Hill. Vein 6 inches wide. Tunnel 100 feet. Ore carbonate and gray copper.

Larkin Mine, Diamond Springs; located in section 29, township 10 north, range 11 east, Mount Diablo meridian, one and a half miles west of Diamond Springs, on the Southern Pacific; owner, Warren Larkin, Placerville, California. Area, 48 acres (patented). Strike of vein, north 22 degrees east; dip, 80 degrees east. Walls, schist. Elevation, 1910 feet. Vein, 3 feet wide. Ore: chalcopyrite, malachite, iron pyrite, iron oxide, gold, silver, quartz. Shoots dip north. Few tons of ore on dump. Reported values, copper, 10 per cent; sulphur, 40 per cent; gold, $2; silver, trace. Development, 160-foot vertical 2-compartment shaft; 140-foot drifts. Equipment, 4-post head frame; 2-cylinder, single motion geared hoist; 30-horsepower. Also pumping engine; power, steam. Gossan, iron-stained schist. California Sash and Door Company's narrow gauge railroad runs within 400 feet of this property.

Hale Mine, Fairplay; located in section 25, township 9 north, range 12 east, Mount Diablo meridian; owner, N. B. Hale, Fairplay, California; south extension of Cosumnes mine. Reported as showing some copper.

Revoir Mine, Pilot Hill; located in section 12, township 11 north, range 8 east, Mount Diablo meridian; eleven miles west to Newcastle on Southern Pacific. Area, 160 acres (patent). Elevation, 1675 feet. Strike of vein, north; dip, east. South extension of Costa claim. This covers main peak of Pilot Hill. Good wagon road to Newcastle.

Oest Mine.—This mine is located seven miles north, one half mile east of Auburn, in section 4, township 13 north, range 8 east, Mount Diablo meridian; owner, H. Oest, Auburn. Area, 10 acres. Strike, north and south; dip, 75 degrees east. Walls, diorite and schist. Ore: chalcopyrite, iron pyrite, some native copper, malachite; very little gossan. Width of vein could not be determined. Development, 2-compartment vertical shaft, depth of which could not be determined, but was reported as 70 feet. Elevation, 1490 feet.

Equipment, 2-post head frame, about 18 feet high. Blacksmith shop. Good wagon road to Auburn.

Cambrian Mine.—Lotus post office. Development, lower adit about 2500 feet. Otherwise about same as 1902, Bulletin No. 23. Work was stopped about the time No. 23 was published, and there has been no work since.

Pioneer.—Located in section 3, township 11 north, range 9 east, Mount Diablo meridian. Thirteen miles northwest to Auburn, on Southern Pacific. Owner, William Haaker, New York City. Area, 80 acres (patent). Strike of vein, north; dip, west; hanging wall, diorite; foot wall, granodiorite. Elevation, 1010 feet. Ore: bornite, malachite, chalcopyrite, iron oxide, iron pyrite, quartz, gold and silver. Gossan, some hematite and magnetite; iron-stained diorite.

Irland, Placerville; located in section 15, township 10 north, range 10 east, Mount Diablo meridian, three miles northeast to Placerville on Southern Pacific Railroad; owner, H. R. Irland, Placerville, California. Area, 420 acres (patent); strike of vein, north; dip, east; walls, granodiorite. Elevation, 1510 feet. Ore: chalcopyrite, gossan, iron-stained granodiorite. Development, 75-foot vertical shaft, 2-compartment; 18-foot drift from deep shaft. Values reported, 2 per cent copper. Some gold and silver. Under bond to Barry & Wilkins. Some ore taken from deep shaft and shipped to Wales, England, about 1866.

Costa Ranch.—This mine is located in section 12, township 11 north, range 8 east, Mount Diablo meridian, eleven miles west to Newcastle, on Southern Pacific Railroad; owner, Frank Costa, Pilot Hill, El Dorado County. Area, 160 acres (patented). Elevation, 1625 feet; strike, north; dip, east. Development, 60-foot vertical shaft in rhyolite. Several cuts, most of them caved. Ore: some malachite, chalcopyrite, quartz, iron pyrite. Geology: cap of hill, rhyolite. Beneath this shows an andesite. On foot wall side shows diorite. Not enough work to determine other wall. Work done on north peak of Pilot Hill.

E. E.—Situated in section 18, township 9 north, range 11 east, Mount Diablo meridian; owner, Joseph Schupple, El

Dorado. Four and one half miles northwest to El Dorado on Southern Pacific Railroad. Area, 60 acres (locations); strike of vein, 4 degrees east; dip, 85 degrees east; walls, slate. Elevation, 1180 feet. Ore: bornite, chalcopyrite, iron pyrite, gold, silver, quartz. Values reported, copper, 15 per cent; gold, $1; silver, 1 ounce. Gossan, small amount of hematite and iron-stained slate. Vein, 2 feet wide. Power, steam, 12-horsepower. Development, 85-foot vertical shaft, single compartment; 60 feet drifting; 1 300-foot adit; 1 100-foot adit.

About a mile north of Latrobe a prospect owned by W. W. Woods displays a shaft 12 feet deep in a vein 5 feet wide. Strong iron capping. Vein matter schistose diabase. Ore, sulphide and oxides of copper.

Bunker Hill Claim.—In section 14, township 12 north, range 9 east, four miles southwest of Greenwood. There is a shaft 60 feet deep. Good ore. Owner, Mr. Terry.

Rip and Tear Mine.—Two miles north of Latrobe. The owner, W. H. Dodson, has 160 acres patented, on which the copper belt appears. There is a shaft 100 feet deep, showing massive pyrite containing copper. Some ore has been shipped. The ores are sulphide, green carbonate, and red oxide. The vein is about 5 feet wide. Still farther north about one mile, there is on the same property another shaft 40 feet deep. The formation of the latter claim is the same as that of the former.

Bob Mine.—This is a patented claim, formerly known as the Iron Crown mine. It is owned by S. B. Selkirk and Col. George W. Dent, and is located in section 13, township 12 north, range 10 east, one and one quarter miles east of Georgetown. There is a gossan capping from 40 to 300 feet wide. The croppings show distinctly in one place 200 feet in width and can be traced for 800 feet in length. The ledge can be traced for ten miles north and south. One spur on the north end crops 40 feet wide about 400 feet south of the north line. About 1200 feet from the south line Miller & Barklege are running a tunnel to tap the ledge at a depth of 200 feet. Farther south on same belt at the Ford mine considerable work

is being done. Beyond the Ford mine only croppings show, no work having been done. There are two locations north of the Bob claim showing strong croppings of copper. No work has been done on them. The developments in the Bob mine consist of one 75-foot shaft, which was sunk on the east wall, and two shallow cuts. The shaft was sunk to reach the ledge at a depth of 100 feet. The water in the shaft carries copper in solution. The vein is between serpentine and slate walls, highly mineralized. The Dark Canyon ditch runs through the claim. From 12 to 15 per cent of copper and $30 in gold are the reported values in the Ford mine on the same belt as the Bob mine. In the Bob mine the reported values are $7 in gold, silver 1.58 ounce, besides some copper.

Noonday.—A prospect in the Diamond Springs mining district, in section 18, township 9 north, range 11 east, owned by Wrenn & Proctor of Placerville. Shafts, respectively 17 and 28 feet deep, showed a 6-foot vein carrying ore yielding from traces to 10 per cent of copper and about $3 in gold per ton, with a little silver. Since the mine was visited it has been bonded by the Peyton Chemical Company of San Francisco, which has proceeded with development. This company is the present owner of the property, which consists of sixty acres mineral locations. Formation, slate with small diabase dikes; veins about 7 feet wide; strike, north 4 degrees east; dip, 85 degrees east. Ore, sulphides, reported to assay copper 5 per cent, gold $2 per ton, and some silver. Shaft, 2-compartment, 130 feet deep, with steam hoist; 280-foot drifts in ore. Equipped with necessary buildings and a 60-horsepower steam engine; fuel, crude oil. Twelve men employed. Elevation, 1130 feet; distance to El Dorado, on the Southern Pacific Railroad, four and one half miles.

A few tons of copper ore assaying from 15 to 18 per cent, with some gold and silver, have been shipped, during development, from a claim in section 8, township 13 north, range 8 east, seven miles north of Auburn, and owned by Peter Oest of Auburn.

AMADOR COUNTY.

Amador County, chiefly famed for its gold mines, holds high rank in copper resources and total output of copper among the counties of the foothill belt. It displays copper-bearing formations similar to those of its neighbor on the south, Calaveras County, in which the copper industry of the State began, and in which the most important mines of the copper belt have been developed. In 1861 and the succeeding years of that period, several mines which were opened yielded considerable quantities of shipping ore, but only one has ever been equipped with a reduction plant worthy of note. This is the Newton, which has been one of the leading and well-known copper mines of the belt for a long period, though for a number of years it has been idle or worked on a small scale. It has a smelting plant of small capacity, but the intermittent operations of recent years have been confined to leaching ore piles, chiefly the old dumps.

This is a comparatively small county, reaching as a narrow strip from the summit of the Sierra range to the low foothills. In the higher Sierras are splendid forests and many lakes, the latter including the group known as the Blue Lakes, which conserve the water supply of an extensive canal and ditch system, and also of one of the largest electric power plants of the State. Amador is distinctly a gold-mining county, and one of the leading ones of the State, as its gold output of $1,373,788 in 1900 testifies. Its fame as a mining county rests mainly on the section of the Mother Lode belt that crosses it. Along this belt are ranged the Kennedy, Argonaut, Zeile, Oneida, Central Eureka, Wildman-Mahoney, Keystone, and other widely known gold quartz mines. Here has been the chief scene of the successful reopening of old quartz mines at great depth, and of the demonstration of the deep values of the Mother Lode. Lignite has been mined in the western portion of the county for many years. Marble and building stone are quarried, and pottery clay is actively produced. Quite a number of diamonds have been found in auriferous gravels covering volcanic formations near Volcano.

A branch railroad reaches Ione in the foothills, which has been extended.

The copper deposits occur in amphibolite schist on both sides of a narow strip of little more than a mile in width, of Mariposa slates, traversing the county in a direction south by east to north by west from the Mokelumne to the Cosumnes River, extending north into El Dorado and south into Calaveras County. On the eastern belt are located the Copper Hill, the Newton, and the Copperopolis mines in Calaveras County, and a number of prospects. On the western belt are situated the properties of the Pacific Improvement Company, the Penn Chemical Company, in Calaveras County, and various undeveloped properties between them.

The character of the ores is essentially the same in all the deposits, chalcopyrite with iron pyrites forming the bulk, the richer oxides and sulphides being comparatively rare, but they differ somewhat in composition. The ores from the Newton and Copperopolis mines on the eastern belt (the Copper Hill mine forms an exception) are distinguished by their purity, containing neither zinc nor any other injurious elements in appreciable quantities and very little gold and silver, while those from the western belt, the Campo Seco mines et al., carry more of these obnoxious metals and also greater values in gold and silver.

Newton Mine.—This has been the principal copper mine of Amador County during the past forty years and is one of the oldest and most extensively developed mines of the foothill copper belt. It is located at Ranlett, four miles east of Ione, on the stage road to Jackson and Sutter Creek. It was opened in the early sixties and worked quite vigorously prior to 1866. Since then, operations have been intermittent and generally on a small scale. In 1886 it passed to its present owners, the Newton Copper Company, Col. Horace D. Ranlett, of Ranlett, one of the oldest copper operators of the State, president and manager. It was reopened in 1887, was worked at intervals thereafter, and in 1889 an 80-ton smelter was installed. During 1891 leaching ore for cement was active and still continues. This mine is in one of the lodes that can be traced for several miles through this portion of the county.

The gossan-capped vein is from 4 to 8 feet wide, courses east of north, dips 70 degrees to the east, and displays solid lenticular ore bodies, not mingled with the containing rock, as is the case at Copperopolis and mines elsewhere. The property has been opened by two shafts, one 150 and one 430 feet deep, and by 2000 feet of drifts on four levels, besides winzes and stopes. The richest ores were yielded in the workings at the south end of the mine, from which much ore running 15 to 25 per cent was shipped long ago, and where mining ceased at 300 feet. To the north of the main shaft, where more recent operations have been carried on, the ore is reported to average 7 per cent. The ores are sulphides and carry small gold values. They are well adapted for leaching. One interesting feature of this mine is the extensive mineralization of the foot wall, composed of sandstone and mineralized slate. It was but recently discovered that here the country rock, to a distance of 15 to 25 feet from the vein, was filled with mineral depositions, mainly sulphurets, carrying 3 to 6 per cent copper and considerable iron. This mineralized mass, which accompanies the vein as far as explored, exhibits partial oxidation to a considerable depth. The material easily disintegrates, and under all the circumstances could be cheaply mined. The most recent period of activity at the Newton mine began in 1899, under the stimulus of copper prices. A smelting plant, consisting of one 80-ton water-jacket blast furnace of modern type, was installed and the surface plant generally improved. The hoist is now capable of operating to 1000 feet. During 1900, 3500 tons of 7 per cent ore were mined. After heap roasting, 3000 tons of the ore were smelted to a 50 per cent matte in a campaign of forty days. Five hundred tons of the newly mined ore remained as fines, and went to join the old dumps for leaching. The matte produced was shipped to Liverpool, paying $20 per ton railroad charges to New York en route. Since then, custom reduction plants, which include converters, have been established in California, affording a distinct improvement in the conditions encountered by any copper property equipped with a small furnace in which ores can be concentrated to matte. Since this campaign, the smelter has remained idle, through circumstances not involv-

ing its efficiency. During the recent mining operations noted, a drift on the 400-foot level was extended north 150 feet, passing out of the old ore shoot, 400 feet long, and reaching a short distance into another one that awaits exploration. Throughout 1901, leaching operations were actively conducted, and about 40 tons of copper cement were produced from the old dumps, and the fines from recent roasting. The dumps contain about 10,000 tons of ore roasted in past years and repeatedly leached, some of it twenty times. The sluices, carrying scrap iron, through which the water percolating through the dumps is carried, aggregate 750 feet. The precipitated cement produced carried 75 to 80 per cent of copper. During the year, the cost of production, including labor, scrap iron, and water, and excluding the original costs of mining and roasting, was less than 3 cents per pound of copper. While the price of copper was maintained, this cement brought in San Francisco 12 cents per pound for its copper contents. Sacking and transportation to New York via San Francisco cost about one cent per pound of copper contents. The total output of the mine to date is reported as 33,000 tons of ore, two thirds of which has been worked on the ground. Two 20-foot winzes and the shaft sump show that the 400-foot ore body mined maintains its width and values below the 400-foot level. These openings and the 150-foot extension of the 400-foot level constitute the only exploration in advance of mining operations.

Moon Mine.—Owned by the Moon Gold Mining Company of Valley Springs, of which J. B. Lucas is vice-president and superintendent. Situated in sections 3, 9, and 10, township 5 north, range 10 east, about two and a half miles east of Richey, and southerly from the Newton mine. There are two shafts, one of which, equipped with a horse-whim, is 100 feet deep. The other is 140 feet deep. The mineralized zone is over 1000 feet wide. Formation, diabase schist down to talcose schist; course of vein, northwest and southeast. The vein stuff is a mineralization of the schist. No large deposits of pyrite or chalcopyrite are yet reached. Gossan croppings are from 18 inches to 8 feet in width. Granodiorite runs to the east of all prospects in this neighborhood. The vein matter also resembles closely that of the mines in Mariposa County.

There are several abandoned shafts in this vicinity, on the dumps of which the same kind of vein stuff and ore can still be observed. To the west of the Moon 1000 feet is another old shaft, 140 feet deep, showing the same sort of formation as does the Moon.

Thayer Mine.—In section 23, township 5 north, range 10 east, a little north of the Calaveras River, on a continuation of the Satellite vein. It is opened by cuts and a main shaft, 240 feet deep. This shaft is equipped with a horse-whim. The ore is sulphide below and carbonate above.

Ione City Mine.—This property, opened in the sixties, is in sections 3 and 4, township 5 north, range 10 east. Ore sulphide and vein matter amphibolite schist, with no iron capping. Owner, J. Boone.

Chaparral Mine.—In section 10, township 5 north, range 10 east; has a shaft 120 feet deep, which was opened in 1864. Now idle. The ore is sulphide and decomposed ironstone. Vein formation, schistose diabase and amphibolite schist.

Russel Mine.—This is on the Russel ranch, section 10, township 5 north, range 10 east. The shaft is 200 feet deep. There is a large dump, 80 by 20 feet, of highly mineralized rock. The vein formation is schistose diabase. Owner, H. Russel.

Bull Run Mine.—On Wharf's ranch, in section 15, township 5 north, range 10 east. Shaft 400 feet deep. Large dump of sulphide ore. Formation of vein, schistose diabase. Ore was shipped in the sixties from this property. It was the reported intention to work this and the Russel mine under the direction of the Buena Vista Copper Mining Company.

The Thayer mine has been added to the property of the Penn Chemical Company.

A group of mines are situated in the northwestern part of the county in a broad, triangular formation of igneous rock, quartz porphyry, resting with the base on the Cosumnes River, and extending about three miles south. The principal vein, the Cosumnes lode, known since 1860, carries high-grade sulphide in a gangue of black shale and quartz. A parallel vein of quartz carrying iron and copper sulphides has been discovered at a short distance west of the main lode. This country consists of low hills mostly covered with grass,

and has been taken up for ranching purposes in large tracts, the mineral veins being included within their boundaries.

The Copper Hill Mine.—This property comprises 2500 acres of patented land, owned by W. F. Detert, of Jackson, and that portion on which the old workings are located lies in sections 34 and 35, township 8 north, range 9 east. Large slag dumps show that at some time in the past the mines produced considerable ore. After a long period of idleness the mines were opened again. The main shaft is situated on the Cosumnes vein, running south by east and north by west, dipping north by east about 60 degrees, varying in width from 2 to 4 feet, and, judging by the size of the stopes, forms much larger bodies in places. The ore is principally a fine-grained, massive chalcopyrite, said to assay from 20 to 30 per cent copper, and to contain appreciable values in gold and silver. The shaft is equipped with a 10 by 12 double-cylinder steam hoist, and has attained a depth of 500 feet. At the 80-foot level a drift runs north 150 feet and south 200 feet. At the 130-foot level a drift runs south 120 feet, and connects by a 50-foot crosscut with the workings of another shaft; another drift runs 280 feet west; on the 230-foot level a drift runs 100 feet north and 250 feet south. On the 250-foot level one drift runs south 228 feet and one north 328 feet, from which most of the good looking ore on the dump has been taken. A short distance from the main shaft is located the southeast shaft, on a vein running parallel with the Cosumnes vein, about 50 feet east of it. It is a 3-compartment incline and equipped with an 8 by 12 double-cylinder steam hoist. The incline is 144 feet deep, and from the bottom runs one drift 50 feet south and one 28 feet north, connecting with the crosscut from the main shaft. In all other respects, this vein is identical with the Cosumnes vein, and perhaps it may be a spur only of the latter. Several hundred feet west of these veins, a shaft, the "Blind Pigeon," was sunk 130 feet on a quartz vein carrying iron and copper sulphides and some zinc. Numerous prospect holes have been sunk along the outcrop of the main vein, of which the following are the most important: The Pine Tree shaft, 1500 feet south of main shaft, 90 feet deep; Little Oak shaft, 150 feet south of southeast shaft, 90 feet deep; air shaft, southeast of main shaft, 150 feet deep;

zinc shaft, 900 feet north of southeast shaft, 100 feet deep. There are over 1200 feet of shafts and over 1800 feet of drifts, or more than 3000 feet of workings in the mines and of surface improvements; there are besides the shaft houses, workshops and buildings for the accommodation of the working force.

The Johnson Ranch Mine.—This property is located on Stony Creek, about five miles southwest of Jackson, in sections 25, 35, and 36, township 6 north, range 10 east. The vein lies between the greenstone and slate, course west by north, dip northeast, and two shafts have been sunk on it. The one farthest south is said to be 90 feet deep, with 5 to 6 feet of vein carrying ore reported at 2.6 per cent copper, $3.75 in gold, and a little silver. About 1500 feet north there is another shaft said to be 60 feet deep, with a 12-foot vein in the bottom, carrying ore of a reported value of 10 per cent copper, $24 in gold, and $4 silver. Owner, Frank Johnson; post office, Jackson.

The Ione Coal and Iron Company, a branch of the Pacific Improvement Company, office Crocker building, San Francisco, has opened an old mine on its patented ground near Irish Hill, about three miles north of Ione. The vein is about 4 feet wide, with amphibolite schist for hanging and aluminous shales for foot wall; course north by west, dip 70 degrees east by north; ore, copper and iron sulphides, with considerable quartz. A steam hoist has been installed at the 300-foot shaft. The outcrop can be traced for a long distance, and four shafts are located within 1000 feet from the main shaft. Superintendent, I. W. Tantau, Ione.

Mineral City Mine.—In township 8 north, range 9 east; owned by T. H. Allen, Jr. Shows indications of copper. The property is a half mile northwest of Forest Home, and comprises 160 acres of patented ground. Inclosing rock the same as old Copper Hill.

Forest Home Mining Co.—Property is a half mile north of Forest Home. W. H. Bradley, of Redlands, Cal., representative. There are four shafts, each about 80 feet deep. All the shafts show indications of copper ore.

Mutual Life Insurance Co.—This corporation owns 2700 acres of land one mile north of Forest Home, on which there are five shafts of unknown depths, whose dump piles all show copper ore.

W. H. Whittle owns 2000 acres one mile southeast of Forest Home, on which there is one shaft 100 feet deep, with 50-foot drifts each way from bottom, showing indications of copper ore.

An old copper mine located at Dry Creek, where the road crosses from Irish Hill to Ione, was closed many years ago. It is reported that matte was shipped from this claim thirty years ago.

CALAVERAS COUNTY.

In Calaveras County the foothill copper belt has displayed its most extensively developed mines, and from this county has come the bulk of the total copper product of the belt. Until the opening of the Shasta County mines in quite recent years this county was the preëminent copper county of the State, though its actual current production was generally small.

Calaveras County is the central one of the Mother Lode counties, and it is also centrally located relative to the entire auriferous slate belt of the Sierra Nevada slope. It is triangular in shape, the apex resting on the crest of the Sierras, the base expanding along the edge of the San Joaquin Valley, and the Mokelumne and Stanislaus rivers, respectively, separating it from Amador County on the north and Tuolumne County on the south. One feature of its forest region is the noted Calaveras grove of "big trees" (*Sequoia gigantea*).

All physical conditions are favorable to mining. The county is richly mineralized throughout, presenting several mineral belts and districts. The Mother Lode crosses the county along a 30-mile course, and in this county displays the characteristics of vast bodies of low and medium grade ore, presenting mining propositions of the sort now especially attractive to conservative mining capital. On this lode, at the northern side of the county, is the noted Gwin quartz mine; by the southern

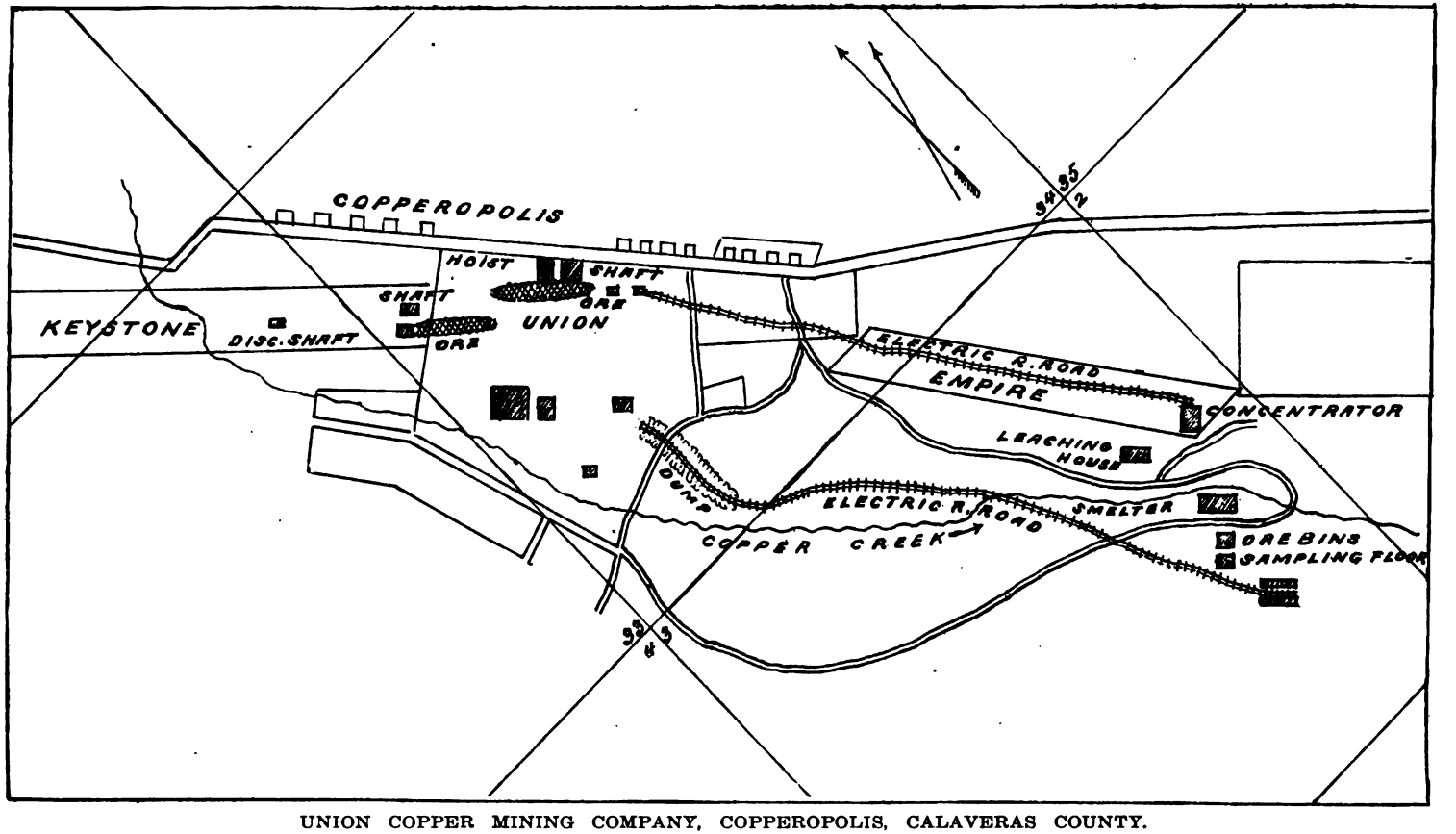
boundary is the Melones, one of the largest mining properties in the State; and between them is the Utica group, one of the ranking gold mines of the country. Other important mines are ranged along the lode. The east belt, farther up the slope, includes the noted Sheep Ranch mine. Other belts and districts reinforce the great and comparatively slightly developed gold resources of the county, which are now attracting marked attention. The auriferous gravel deposits of ancient river channels aggregate 50 miles in length. The gold product in 1906 was $2,260,376, and the total mineral output $2,305,943. Quartz crystals of rare size and quality are mined near Mokelumne Hill. Various minerals characteristic of the slope abound and await utilization. The foothill region, in which the copper deposits occur, also presents some valuable gold quartz veins.

The copper belt, which crosses the eastern side of the county through the foothills in a northwesterly and southeasterly direction, separated from the Mother Lode belt by the Bear Mountain range, here displays two important lodes. The main one crosses the county and appears to present a fairly continuous system of veins, which display considerable variations of contents, inclosing formations, etc. At Campo Seco, on the northern boundary of the county, is a group of patented claims, quite extensively developed, which display strong veins and ores carrying some gold and silver. Well toward the south side of the country are the mines at Copperopolis, the most important of the entire belt in the past, and here gold is absent from the ores. The practical continuity of this lode is shown by croppings and a great number of shallow shafts sunk all along the lode at various times. A few miles westward of this lode is another one which is traced for a number of miles and in which is the Napoleon, the pioneer developed copper mine of the State. Heavy gossan cappings characterize both lodes. In early days several mines on these lodes other than those of present interest here described were opened to considerable depths and shipped more or less ore, but they are now forgotten. Some may again be prospected at a future time.

Union Mine.—By far the most important copper mining property developed in California prior to 1896 is the extensive

one known since the beginning of copper mining in California as the Union. For a great many years it has included the Keystone, which was, during the same period, the copper mine of second rank in the State. These two patented mines constitute the historical and widely known "Copperopolis Mines." They are in the town of Copperopolis, which they created in a little valley in the southwestern portion of Calaveras County, and in section 34, township 2 north, range 12 east, on the main lode of the foothill copper belt, which here strikes 30 degrees east of south and dips about 60 degrees east. The elevation is 1000 feet. The Union was the first copper mine of the State to be productively developed on an important scale. Large bodies of rich ore were encountered near the surface and persisted downward, and for several years succeeding January, 1861, this mine produced the bulk of the California copper ores mined and shipped. In 1866, a year or two before the Union first closed, it was credited with having shipped 56,500 tons of ore assaying 15 per cent or more, and a much greater quantity of ore of lower grade had been mined. The second largest producer at that time, the Keystone, was credited with 5719 tons shipped. The story of the Keystone during this period runs on similar lines, but this mine did not approach the success of the Union, which paid large dividends and was once held at a valuation of about $4,000,000. Both mines were then opened to about the present depth, and operations ceased with good ore bodies displayed by the lowest workings. At 500 feet the Union shaft was in an ore body 15 feet wide and of medium grade. The Union remained closed from 1868 to 1887, nineteen years. In the latter year it was unwatered under the management of H. D. Ranlett. The main shaft was sunk to 600 feet, and mining was resumed for about a year and a half, during which time 5000 or 6000 tons of ore were shipped. In 1889 a 100-ton Orford smelting furnace was installed, without very successful results. Operations again ceased in 1892. Leaching the dumps has been carried on during many years and a large amount of cement copper has been produced.

The formation in which these mines occur is black pyritous slate and amphibolite schists and can be traced through Calaveras County north into Amador County and south into Tuolumne County. The lode in which are the Napoleon and Campo



UNION COPPER MINING COMPANY, COPPEROPOLIS, CALAVERAS COUNTY.

Seco mines is to the westward, the distance being about six miles from Copperopolis, while the Campo Seco mines at the northern boundary of the county are about three miles west of the Copperopolis lode, as the latter is termed in this county. At the Union mine, and for a considerable distance north and south, this lode presents a single vein of black pyritous slate in a belt of amphibolite schist, this formation exhibiting no

SMELTER OF UNION COPPER MINING COMPANY, COPPEROPOLIS, CALAVERAS COUNTY.

material variations. The United States Geological Survey has shown both vein and inclosing formation to be identical in age and character with the slaty veins and amphibolite schists (greenstones) of the parallel Mother Lode about twelve miles to the east. At Copperopolis the vein is from 3 to 40 feet wide, and occupies the trough of a small valley which here averages a half mile in width, the valley itself being the result of the erosion of the soft slate and of the softer greenstones directly bounding it. Being covered by detritus and vegetation the vein exhibits no croppings in the immediate vicinity of Copperopolis, and copper stains were the only indications which

guided the prospecting that led to the discovery of the rich ore bodies below.

The Union and Keystone patented claims comprise 5254 feet of the lode. The property of the Union Copper Mining Company, which is controlled by the estate of Frederick L. Ames, of Boston, also includes the Empire, the undeveloped south extension of the Union, and 800 acres of patented agricultural

CONCENTRATOR, UNION COPPER MINING COMPANY, COPPEROPOLIS, CALAVERAS COUNTY.

land north and south of the mines, giving the company possession of over three miles of the lode. Production has been confined to the Union claim and the south end of the Keystone claim, and underground exploration practically so. The vein, which in these claims exhibits a maximum width of about 40 feet and an average width of about 15 feet, carries a succession of ore bodies which are lenticular masses of sulphide copper ore (chalcopyrite) connected by stringers of ore. The water level is here very close to the surface, and the alteration of the sulphides has extended to a depth of about 30 feet only. Within this zone of oxidation the ore bodies below the surface gossan

present a little native copper, and carbonates and oxides that are frequently very rich. There is no zone of secondary enrichment, and below the depth of 30 feet the unaltered sulphides extend downward practically unchanged in character and average copper content to the greatest depths yet reached.

Three ore bodies have as yet been opened and worked. Two of these outcrop in the Union and one near the south end of the Keystone. These ore shoots dip eastward with the vein and also longitudinally to the north. The largest one is the southernmost one, in the Union claim, and is about 300 feet long, from 2 to 40 feet wide, and has been followed to a depth of 600 feet, where it reaches the northern vertical boundary of the Union claim. One stope in this body, from which ore was extracted in the decade of the sixties, was about 40 feet wide, 80 feet high, and 100 feet long. The next shoot to the north in the Union claim is 200 feet long, is of less average width, and reaches well into the Keystone property, where it has been worked to the same depth as the larger ore body. The developed Keystone ore body is 100 feet long, from 1 to 15 feet wide, and is exactly similar to the others in character. It has been worked to a depth of 250 feet. The underground openings of the Union and Keystone claims, consisting of several thousand feet of drifts, shafts, and stopes, are connected. Nine levels have been run in the mine and six shafts have been sunk to varying depths on both properties.

The question of the permanence of values at depth in this foothill mineral belt is, in a way, quite as interesting and important as the same question in regard to the parallel Mother Lode. Within recent years this question has been affirmatively decided along the Mother Lode, especially in the neighboring county of Amador, and at the Gwin mine, in Calaveras County, where extensive and valuable ore bodies are being mined at a present depth of about 2000 feet. This problem gives significance to the persistent characteristics of the ore shoots at Copperopolis and to the geological identity of the veins and inclosing formations of both lodes.

Within the limits of the Union and Keystone claims, and outside of them along the lode through this company's property, superficial prospecting has revealed the buried outcrops of a number of other bodies, all of which are remarkable

in their similarity to the three developed ore bodies at the surface. The prospecting and developing of such new ore bodies await the future.

The Union ore bodies are, as indicated, practically solid masses of sulphides, carry no gold or silver, and are exceptionally free from baser metallic elements. These ores thus differ from those of the Napoleon-Campo Seco lode to the west, which carry gold, silver, and baser elements. It is stated that the copper product of this mine has generally been used for the manufacture of copper wire without electrolytic refining.

The product has been two grades of ore—one a smelting ore averaging 11 per cent of copper, and the other a leaching ore averaging 5 to 5½ per cent. The mining operations have yielded about two tons of the latter to one of the former, but the low-grade leaching ore has been largely taken from the radiating stringers.

The surface plants, erected years ago, are extensive and include a large leaching plant, necessary buildings, hoist, pumping plant, etc. The mine yields a maximum of 80,000 gallons of water per twenty-four hours. Steam power is used, wood costing from $3.50 to $4 per cord. Water is pumped from a creek half a mile distant. Timbers and lumber are supplied from Stockton and the mountains to the east. The Union Electric Light and Power Company, which is under the same control as the mine, owns 1200 acres of land, largely gold placer ground, on the Stanislaus River at the southern boundary of the county, and there are several miles of water ditch. This property was secured to provide a supply of water and power for the mine and town.

The company has added to its holdings by purchasing adjoining property, and now owns besides the Empire, Union, and Keystone claims, over 1500 acres of patented ground.

Important improvements have been made on top, and the geological and mineralogical conditions of the mine have been carefully studied by John A. Reid, who has published the results of his investigations in a monograph entitled "The Ore Deposits of Copperopolis, Calaveras County, California," which gives a minute description of the ore deposits and the formation in which they occur. According to this author the amphibolite schists in which the copper mines of Amador

County and in the northern part of Calaveras County are situated do not enter this section, but come to an end about two miles north of Copperopolis. The hills flanking the narrow valley in which the camp is located on the east and west, are formed by meta-andesite (augite porphyry) intercalated with beds of chlorite schists. The vein which occupies nearly the center of the valley, lies in a narrow strip of Mariposa slates which gradually merges into the schists on both sides. The ore-bearing formation is chlorite schist about 100 feet wide, with scarcely any other gangue rock minerals. The hanging wall is formed by slate throughout, but the foot wall is formed in places by a thin layer of serpentine, separated from the ore by a band of talc. Of the two principal ore bodies, No. 1 lies east on the hanging wall, No. 2 west on the foot wall and north of it, extending into the Keystone. In the lowest levels, at a depth of 600 feet, they show no change in the character of the ore and size, the width varying from 30 to 50 feet and over. Lately only the main Union shaft on the east shoot was used for hoisting, but the Keystone shaft on the west shoot, 400 feet deep, was being put in shape. It is equipped with a steam hoist and a steel gallows frame, fitted with iron ore bins. There are two levels in this shaft, from which it is stated good ore has been taken. Eight levels have been run from the main shaft, and from the six lower levels crosscuts extend through the west vein to the foot wall. Two winzes have been sunk in the bottom of the lowest level, one near the main shaft, 25 feet deep, and one in the west ore shoot 80 feet deep, with a drift in the bottom, both showing the ore body undiminished in size and the ore improved in grade. A drift from the seventh level connects with the Keystone shaft.

The following analysis of the lower grade, or concentrating ore, is given in Mr. Reid's assay:

SiO_2	21.14
Al_2O_3	14.10
FeO	13.91
Fe_2O_3	11.51
CaO	.69
MgO	8.50
K2O	Trace
MnO	Trace
P_2O_5	Trace
H_2O	6.90
$CuFS_2$	11.12
	96.97

The reduction plant is located about half a mile south of the main shaft, down the valley, where it has contracted to a narrow gulch, and consists of a smelter and concentrating mill, besides the old plant for leaching, which is still employed on a limited scale. The smelter occupies the western slope of the valley and has a 60-ton reverberatory furnace, with room for the erection of a second one. An electric railway on top of the ridge connects with the smelter and carries the ore to a building containing a stone breaker and sampling room, from which it is delivered into the ore bins below, and discharged into cars running on a level with the feed floor. All these buildings are

UNION COPPER MINE, COPPEROPOLIS.

constructed of iron and are fireproof. The product is a high-grade matte shipped to eastern refineries. The concentrating mill is situated opposite the smelter on the eastern slope of the gulch. It has five floors, arranged in terraces, with a vertical elevation of 105 feet. It is connected, the same as the smelter, with the two shafts by an electric railway, which runs on a high trestle nearly the entire distance. The ore is delivered into bins, from which it is transferred by a belt conveyor to a rock crusher on the fifth floor, and thence it passes through a set of four sizing drums to ten jigs for medium and one for coarse size on the fourth floor, where are also two sets of Cornish rolls. On the third floor are two Huntington mills and Cornish rolls, and on the second ten jigs for a finer grade. Finally, there are two Wilfley, two Standard, and two Frue

Vanner tables on the ground floor, and belt elevators to carry the ore to the upper floors. The motive power is electricity and the capacity of the mill will be 250 to 300 tons per day.

Two thousand feet north of the Keystone shaft are some old workings, which must have been somewhat extensive, judging from the size of the dump, and which, it is said, have produced some of the richest ore shipped from the mines. Excepting these, and the drifts in the Keystone shaft, the ground between them has remained unexplored.

Among other surface improvements may be mentioned five traction engines, which are used for hauling supplies, etc., from Milton. G. A. Clothier has charge of the property.

Penn Chemical Works.—The property of this company consists essentially of the Hekla, Campo Seco and Satellite, which were operated as separate mines in former years, to which the little Satellite and some other claims have been added. The first three mentioned were producing mines in the early sixties and were important ones in those days. They are close to the town of Campo Seco, by Mokelumne River, about twenty miles northwest of Copperopolis, and on the western lode of Calaveras County. Valley Springs, the terminus of a narrow-gauge railroad, is four and a half miles distant. In early days many thousand tons of ore were mined. The richest was shipped in considerable quantity, and large amounts of medium and low-grade ores on three dumps have been leached intermittently to the present day. Some matte was produced from small furnaces before the plant now operating was installed. The veins here course and dip as at Copperopolis. The vein matter varies in character, the gangue being variously composed of talcose schist, clay, quartz, etc. The ores are sulphides, associated with iron pyrites, and carrying small percentages of gold and silver, with occasional traces of zinc. This group of claims has been opened by five shafts and some tunnels. The deepest development has occurred in the Hekla and Satellite, which at an early period were opened to depths of about 500 feet. The Campo Seco shaft reached 250 feet, and its lowest level was at 200 feet. One ore body in the Hekla mine was 150 feet long, and the group as a whole has yielded largely. The Satellite has under-

gone the most extensive development. The shaft is 550 feet deep and four levels have been opened, from which ore is now being mined. This mine was well known as the Lancha Plana before 1883, when it was reopened by H. D. Ranlett after long idleness. A tunnel was run to the old shaft, about 1000 tons of ore shipped, and leaching continued for about three years. It was then sold to the San Francisco Copper Company, and later merged with the

PENN COPPER MINING COMPANY'S MINE, AT CAMPO SECO.

Penn Chemical Works property. Mining and prospecting are actively proceeding. The pyritic method of smelting is pursued. The material is run through the furnace three times, producing matte respectively of 20, 40, and 60 per cent. Another feature of the plant is a small furnace used to agglomerate and partially desulphurize the fines. A. C. Harmon, Campo Seco, is general manager.

This property, at present the most important producer south of Shasta County, is situated in section 34, township 5 north, range 10 east, sections 4 and 3, township 4 north, range 10

east. Subsequent developments have shown that the vein splits north of the Campo Seco shaft into an east and west branch which continue parallel in a southerly direction, not far apart, and can be traced by their outcrops for a long distance. The point where the west vein begins is not known, but it must be somewhere between the Mokelumne River and the shaft, because it can be plainly seen west of it, and in the river bed, which cuts deeply through the hills and exposes the formation, only one vein can be found crossing it. The hills

SMELTING WORKS OF THE PENN MINING COMPANY, AT CAMPO SECO.

through which the east vein passes are capped by heavy deposits of auriferous river gravel which has been extensively washed and exposes in many places the heavy gossan on the apex of the vein, making it easy to follow its course. Of the five shafts on the property, three are located on the eastern vein, on the Campo Seco and Hekla claims, and two on the western vein, on the Satellite claim, farther south. Two shafts, one on each branch, serve for hoisting purposes. Beginning at the southern end, shaft No. 1 is 400 feet in depth, it serves for ventilation; No. 2 is 750 feet and the

deepest shaft in camp. It is equipped with a steam hoist and connected with No. 1. About 1300 feet distant, on the east vein, is shaft No. 3, furnished with steam hoist and 550 feet deep. Every hundred feet drifts are run in both directions, and from the 400-foot level a drift extends north 2500 feet, within a few hundred feet from the end line of the Hekla claim, where the vein crosses the river. No. 4 shaft is 400 feet deep and serves as air shaft and man-way. No. 5 shaft on the Hekla is said to be 500 feet deep, and when

PENN CHEMICAL COMPANY'S SMELTER AND ROASTERS, CALAVERAS COUNTY.

finished will connect with the long drift of No. 3. The vein lies between amphibolite schists (often called greenstone or diorite) and talcose shales, which, however, do not contain magnesia, but over 90 per cent silica, and furnish excellent material for furnace lining. In the upper portions of the vein some oxides, copper glance and native copper have been found. In the deeper parts of the mine, the principal ore is chalcopyrite with iron pyrites, with occasionally some copper glance, bornite and covellite. It is reported that the ore bodies attain a thickness of 30 feet in places and contain 7

to 11 per cent copper, $3 to $4.50 gold and $5 to $6 in silver. Most of the ore carries a little zinc, and some of it a rather high percentage. The reduction plant is composed of a water-jacket blast furnace 36 by 72 inches, of 100 tons capacity (about 80 tons net ore); two reverberatory furnaces of 50 and 100 tons and eight McDougall roasting furnaces of 16 tons each, the entire smelting capacity being about 230 tons. The walls of the reverberatory furnaces are lined with chrome-iron, cemented with a mortar made of ground quartz, and the talcose shales mentioned above. A high-grade matte of 60 per cent and over is the final product of the smelting operations. Crude oil is used as fuel for the boilers, the reverberatory furnaces and the locomotives which haul the ore from the mines to the smelter. Electricity generated on the ground, is used for lighting and also for motive power; electric locomotives are employed in the yard for hauling slag pots, etc. Between 150 and 200 men are employed on the premises.

The company has secured the Thayer claim, and considerable ground besides on the northern extension of the vein, across the Mokelumne River, in Amador County.

The Constitution Mine.—South of the property of the Penn Chemical Company are three claims belonging to C. Borger, of Campo Seco, two of which, the Meteor and the Constitution, are located on the southern extension of the east vein; the third, the West Constitution, forming a continuation of the Satellite claim. A shaft has been sunk on the Constitution to a depth of 400 feet, and some good ore has been found scattered through the vein. A shaft was started in the gossan a short distance south of the main shaft, and a streak of ore was discovered which increased at 45 feet to a body of good ore 4 feet wide. The ore is the same as in the Penn Chemical Company's property, and assays of 15 per cent copper, with some values in gold and silver, are reported. Mr. Borger secured the mineral rights on this vein for a considerable distance beyond his property.

Napoleon Mine.—This, the oldest copper mine in the State, lies to the south and west of Copperopolis about nine miles, and is in section 23, township 1 north, range 11 east.

It is thirteen and a half miles from Milton. The owner is Josephine H. Sullivan, who bonded the property to Messrs. Lewis and Ben Williams. The vein channel is 100 feet wide, and consists of diabase and meta-diabase down to talcose schist. The ore bodies occur in lens-shaped masses from stringers to 20 feet in width. The shaft is 86 feet in vertical depth and then inclines 62 degrees for 239 feet, giving a total depth of 325 feet. The ores are principally sulphides, although carbonates and oxides are

NAPOLEON COPPER MINE, CALAVERAS COUNTY.

plentiful. The mine, which was first opened in the sixties, was filled with water from 1866 to 1900, when the Williams Brothers commenced operations. A new west shaft was sunk to connect with old workings on the 250-foot level. Cement copper is produced from leaching the old dumps, and some satisfactory shipments of ore have been made. The mine is now the property of the Peyton Chemical Company. The shaft has reached a depth of 430 feet, and drifts 200 to 300 feet long have been run in the 250, 300, and 400-foot levels. The ore is shipped to the Peyton Chemical Works.

Star and Excelsior.—In section 24, township 1 north, range 11 east, near the Napoleon; opened by cuts, shafts, and tunnels, showing an ore channel from 75 to 100 feet in width. The ores are sulphide and carbonates. The owners are Messrs. Weihe et al., of San Francisco.

Collier Mine.—In section 24, township 1 north, range 11 east, near the Napoleon; owner, Henrietta Botcher, of Stockton. There is an old caved shaft on the property. The vein is reported to have been rich in copper, which was shipped in the sixties.

Eagle Mine.—In section 3, township 1 north, range 11 east, on Quail Hill; owner, J. M. McDonald, of San Francisco. Contains sulphide and carbonate copper ores.

Near Milton are some prospects showing copper, but they are not developed enough to demand specific mention.

Josephine Mine.—In section 8, township 1 north, range 13 east; known also as the Old Mountain Top mine. It has a shaft 40 feet deep, sunk in 1864. The vein is 4 to 5 feet wide. A little ore remains on the dump and in the shaft. Shipments were made from this claim in 1864.

Through the Pattee ranch, adjoining the town of Valley Springs on the east, extends a belt of copper-bearing rock 1000 feet wide, with a strike west of north. The ranch contains 784 acres. On this belt there are shafts and open cuts. The deepest shaft is 80 feet, and shows copper ore. The vein matter here is amphibolite schist and schistose diabase.

The De Martini ranch is the second ranch below the Pattee ranch. Two creeks cut through the belt on this ranch and reveal copper ore.

On the Missenger ranch, about two and a half miles north of Valley Springs, is a shaft about 400 feet deep in the old '49 mine. There is also a large dump of oxidized and sulphide ore. About two and a half miles farther north, near the Mokelumne River, is another shaft called the "Salt Gulch."

Jackson McCarty Mine.—Known also as the old Calaveras mine; about three miles north of Copperopolis, in section 23, township 1 north, range 12 east. It has a shaft 250 feet deep.

Caledonian Mine.—On the road from Valley Springs to Gaslen's ranch; has a shaft 250 feet deep, sunk in the sixties.

The Pool Mine.—This property was turned over to the Nassau Copper Company, which put up a steam hoist and sunk the shaft to 300 feet, with several hundred feet of drifts, etc., and is reported as having taken out $70,000 of ore. The water taken from the mine is run into precipitating tanks. The vein varies from 15 to 30 feet; the ore differs from the ore of the Union mine, carrying more quartz, greater values in gold and silver, and some zinc. An average sample taken across the vein, 20 feet wide, is reported to be composed as follows:

Silica	15%
Iron	40%
Sulphur	22%
Zinc	15%
Copper	7%
Gold	96 oz.
Silver	96 oz.

President, I. E. Porter, No. 1155 Castro street, Oakland, California.

On the road to Angels Camp, three miles north of Copperopolis, in section 2, township 2 north, range 12 east, a prospect is developed by G. A. Clothier and D. H. Cameron, of Copperopolis. The shaft is 35 feet deep and shows an 18-inch streak of solid ore of good grade, similar to the ore of the Pool claim.

East of the Mother Lode there are found occasionally quartz veins carrying copper in considerable quantities, notably on San Domingo Creek, near Macaroni Flat, where there is an old shaft and a large dump, which show considerable copper ore and some native copper.

ALPINE COUNTY.

Some of the occasional occurrences of copper along the higher portion of the Sierra Nevada range are to be noted in Alpine, a small elevated county which straddles the crest of the range and lies east of El Dorado, Amador, and Calaveras counties, and west of Mono County and the State of Nevada. It is remote from railroads, and its small population devotes its energies mainly to mining, stock-raising, and lumbering. Gold and silver-bearing lodes are abundant, but the ores are largely base and the mining industry is in a backward state. Quite a number of important mines have been developed and operated, however. This remote region has frequently, but erroneously, been given the honor of possessing the first copper deposit discovered and opened in the State. This deposit was found in Hope Valley in 1855 by "Uncle Billy" Rogers. The ore occurred in the form of a "chimney," presented a beautiful appearance, was rich in garnets, and attracted considerable attention for a brief time. Other deposits of better commercial value were later discovered and opened. Two have been noted.

Leviathan Mine.—Owned by D. Bari, of Silver Creek, California. The mine is located ten miles east of Markleeville. The nearest point to a railroad is Carson City, forty miles distant. There is a 400-foot tunnel tapping the ledge 250 feet below the outcrop; 200 feet below this tunnel another tunnel is in 700 feet. Both tunnels are connected by a winze. The ore occurs in kidneys in porphyry. About 300 tons of ore have been shipped to a smelter.

Stella Mine.—Located two and a half miles southwest of the Leviathan, and is owned by an English company. The mine has been operated for silver and copper. There is a 300-foot shaft and hoisting apparatus. Water power is available.

The Morning Star mine, an old mine in the Mogul district north of Markleeville, has been again productive. It is operated as a gold and silver property, but the ore carries a good deal of copper. One lot of 22 tons mined in 1901 is reported to have yielded 17 per cent of copper, and $32 in gold and 49 ounces of silver per ton.

TUOLUMNE COUNTY.

Another of the great gold-mining counties of the slope crossed by the foothill copper belt is Tuolumne, a large, irregularly shaped county, which stretches its eastern and longest boundary far along the Sierra crest, reaches westward down the slope between torrential streams, and claims a small section of the foothill region with its narrow western end. It is a part of the Wonderland of the general region of the Yosemite Valley, which lies to the south, and includes about half of the Yosemite National Park and of the Stanislaus forest reserve. Hetch-Hetchy Valley and some of the higher peaks of the range are among the varied features of its scenic grandeur. It has a wealth of natural resources yet but slightly exploited. Agriculture and horticulture flourish more largely than in some neighboring counties, and there is an extensive lumber industry. Splendid opportunities for the extensive generation of electric power are presented.

Mining is yet by far the dominant industry of the county. Its rich early placers have been succeeded by an era of quartz mining, which for some time has been showing marked progress. Few counties of the State have recently attracted so much mining capital to their gold mining fields or seen more active development of successful or promising quartz mines. The Mother Lode crosses its western part and affords some of the best and well-known mines of the State. The east belt, paralleling the Mother Lode, shows its most valuable and most extensively developed mines in Tuolumne County. The base-ore belt of the high Sierras is wholly undeveloped here, as in other counties.

The county's mineral resources are widespread and various, but gold, and a little silver mined with it, yet constitutes the principal mineral product. The output in 1906 was $1,039,675 in gold and $8,476 in silver. Besides the great continuous belts along which gold mining is mainly concentrated, there are districts containing many rich pocket mines. One of these mines has yielded $2,000,000. The Sierra rail-

way crosses the foothill and Mother Lode belts, affording direct communication with the most populous and productive portions of the county.

Through the western end of the county the copper belt presents two branches. It enters the county from the north closer to the Mother Lode belt than elsewhere, being but two or three miles westward. The two divisions of the belt diverge somewhat in crossing the county southeasterly, and both are marked at intervals by outcrops of cupriferous veins and by old shafts of shallow depth, which mark the many prospecting efforts of former periods. A few properties have shipped a little ore, mainly forty years ago, but no mines of note have yet been developed. Many of the deposits carry gold, and in a few gold affords the chief incentive to exploration. The western branch of the belt is the stronger one. From Copperopolis, in Calaveras County, it enters Tuolumne County at Byrne's Ferry, and passes through the Don Pedro district to the southeast. The eastern branch enters the county just west of Tuttletown and passes out at Moccasin Creek at the south. The copper belt is clearly defined, exhibits favorable indications, and, as do other sections of the belt, presents strong possibilities for the future.

On the Kohl ranch, in sections 6 and 7, township 1 north, range 14 east, west of the Rawhide gold mine, and to the west of the Serpentine, the east branch of the copper belt is traced by croppings and cuts. The vein matter here has the appearance of a chloritic schist.

On the Shell ranch, in section 17, township 1 north, range 14 east, southwest of the Rawhide mine, on the flank of Table Mountain, a copper deposit exists. This ore is rich in gold.

In the town of Chinese Camp is an old shaft about 100 feet deep. The dump shows good copper ore. This is in section 9, township 1 south, range 14 east.

On the Olson ranch, in sections 31 and 32, township 2 south, range 14 east, is the old Golden City mine, which shows copper ore. The mine, however, has been worked chiefly for its gold.

On the Mackay ranch, in section 28, township 1 north, range 14 east, is a shaft in croppings showing copper ore, mainly carbonate.

On Moccasin Creek, in sections 19, 20, 28, and 29, township 1 south, range 15 east, are copper croppings and a shaft 22 feet deep, showing chalcopyrite. From the Tuolumne River going south in this range a deposit of copper with heavy ironstone cap can be traced by croppings for over a mile.

Along the west lode the following properties are noted:

Washington Mine.—In sections 30, 31, and 32, township 2 south, range 15 east. The owners are W. E. Hensley and G. A. Hensley. There formerly was a town of over 400 people sustained by the mine. The town was destroyed by fire; the price of copper depreciated; the place was deserted. The ores are of a very good grade, sulphides predominating. The vein formation is diabase and meta-diabase.

On Donahue's ranch, in section 23, township 2 south, range 14 east, there is an old tunnel said to be 1000 feet long, with good copper ore on the dump. The former superintendent, Mr. Z. Brown, shipped some high-grade copper ore.

In the Don Pedro district the copper belt is clearly traced in its course northwesterly. Prospect holes are found in section 9, township 3 south, range 15 east.

On the Blanchard place is a shaft 60 feet deep, in which is exposed good chalcopyrites. At Montezuma is the Ohio House mine, showing good copper ore. On the W. N. Adams place, in section 16, township 3 south, range 15 east, are shafts and open cuts, showing copper ores, which were opened in the sixties.

The Kohl, Shell and Mackay Ranch and Chinese Camp.—No further work has been done on these prospects.

Dan Mahon located two claims, unpatented, on Wood Creek, between Sonora and Chinese Camp, section 27, township 1 north, range 14 east, on copper croppings in serpentine, lying between granite in the east and granodiorite in the west. A 20-foot shaft was sunk in the gossan on the granite contact, showing some copper oxides, and an 18-foot open cut a little west of it in the serpentine shows several streaks of iron and copper sulphides reported to assay 5 per cent copper and $2.50 in gold.

Adjoining the property F. T. Lillard located four claims (unpatented) on an iron outcrop showing copper oxides, which

can be traced for some distance. In a shallow shaft on the hillside a small amount of rich ore, consisting of copper glance and oxides, was found, and a tunnel was started lower down to crosscut the narrow vein. A small pocket of rich ore, similar to that taken out of the shaft was encountered and the face of the tunnel, which is in serpentine, showed streaks of iron oxide. The formation is serpentine. The property is situated in sections 18 and 21, township 1 north, range 14 east.

Oak Hill Copper Mine.—This property is located on patented ground, on a large vein in porphyrite, strike northwest, with slight dip to southwest. Gangue rock consists of clay shale, generally showing a foliated structure, but also forming homogeneous masses without any regular cleavage. Iron pyrites and some copper are disseminated throughout this entire mass, the presence of the latter being proven by the crystals of copper sulphate in all the workings, which in places occur in such masses as to partly cover the walls of the drifts and stopes. The eastern wall of the vein is formed by a quartz dike 30 to 40 feet wide, from which it has been crosscut west 80 feet, without reaching the western wall, so that its width is not yet known. This quartz dike and the adjacent part of the vein crops out on the surface and can be traced over 350 feet, but neither the western part of the vein nor its wall appear on the surface, from which its width could be determined. Two ore shoots are known, one close to the eastern wall, the other near the present western boundary, varying in width from a few feet to 6 feet and more, the old workings near the surface showing stopes 30 feet wide. From the surface to a depth of 100 feet, the ore consists of oxides, carrying a fair percentage of gold. Below that level it is mostly sulphide, pyrites of iron, chalcocite and perhaps some oxide and other metals, the richest ore being black and soft. Chalcopyrite seems to be almost absent in the upper workings, but 6 feet of it have been struck in a drift on the 300-foot level, after passing through 75 feet of the black ore. When the present company took hold of the property in 1901, a new shaft was sunk 150 feet on the west vein, a little north of the old discovery shaft, drifts run from the bottom and the 100-foot level, and the ground between them stoped out. After it

had been worked for two years, and leased for a short time, it was shut down and remained idle until work was resumed under management of C. F. Stocking. A drift was run east to the quartz and the ore shoot discovered, which was stoped up to the 100-foot level, the same as the west shoot. The shaft was sunk to 350 feet, with 300-foot drifts on the 100-foot level; 400-foot drifts on 150-foot level; 350-foot drifts on 300-foot level; altogether there are probably about 2000 feet of development work in the mine. The ore shipped during the first period varied, according to report, from: gold, .22, .71, and .62 of an ounce; silver, 2.38, 7.11, and 6.16 ounces; copper, 4.9, 10.5, and 20.9 per cent. The shaft is equipped with a gasoline hoist, and the buildings necessary for the operation of the mine are on the ground. Manager, C. F. Stocking, La Grange post office; main office, Santa Cruz.

Mitchell or Bonne Terre Mine.—About one mile west of Oak Hill mine, situated on patented ground. The shaft is 100 feet deep, with 100 feet drift on a vein carrying sulphides almost from the surface, besides fair values in gold, but also a high percentage of zinc. Owner, Locke Robinson, M.E., et al., Sonora.

Washington Mine.—Only assessment work done for some years.

East of the Mother Lode, in sections 20 and 21, township 2 north, range 17 east, copper ore in quartz occurs in considerable quantities. This deposit is similar to one described as the Robert mine in El Dorado County. The ore is regarded mostly for its gold value.

MARIPOSA COUNTY.

In Mariposa County the copper belt presents some of the extensive ore bodies developed along the belt outside of the few larger producing mines to the north, and the deposits here are most noteworthy, on account of the large percentage of gold frequently carried by the ores. Some of these ore bodies attracted attention during the earliest years of the

industry, and here were some of the earliest mining operations and attempts at copper smelting. Thousands of tons of ore have been mined and shipped, with or without concentration, and in the sixties the industry supported a considerable population. During a period of copper activity several promising properties, old and new, were opened and actively developed.

Mariposa County covers a large area of the Sierra slope at about the latitude of San Francisco, has an irregularly triangular shape, and, unlike Tuolumne County on its north, has the base of the triangle it constitutes in the foothills and its narrow end near the crest of the range. It shares the rugged topography, forests, and abundant water characteristic of the slope. The county is chiefly known to the world through its possession of those natural wonders, the Yosemite Valley and the chief groves of the kingly *Sequoia gigantea*, or "Big Trees." A branch railroad reaches to Raymond in Madera County close to the southwestern boundary. The Yosemite Valley Railroad, which extends from Merced up the Merced River canyon to El Portal, furnishes transportation facilities nearly to Yosemite Valley. It also furnishes facilities for reaching the mining districts on both sides of the Merced River.

While the county has various resources and attractions, it is and will remain chiefly a mineral county. As such it has an important future. It is full of opportunities for legitimate mining enterprise backed with sufficient capital. The great Mother Lode courses through the county and finds its southern terminus in the southern part of this county, where it loses its identity and is succeeded by the irregular system of quartz veins which continues far southward along the slope. In Mariposa County the Mother Lode is characterized by the great width of its quartz veins and ore bodies. About fifteen miles of the lode are included in the Mariposa Grant, an estate of over 44,000 acres, owned by a company that reopened some old mines, one of which yielded $4,000,000 many years ago. Another section of the lode is included in the 20,000 acres held by the Merced Gold Mining Company. Some miles from the Mother Lode is the east belt, one of whose mines has produced $2,500,000. The copper belt running through the foothills courses for forty miles through Mariposa

County, and here there has been a great deal of activity in the opening of both gold and copper mines. The copper properties here described are mainly taken in succession northward from the south side of the county.

Near the south line of Mariposa County, in range 18 east, is Green Mountain, a considerable prominence through whose summit passes a vein of ironstone carrying copper. This vein is a part of the great California copper belt, and at this locality has a large, heavy, bold cropping of gossan, which is a hydrated, silicious iron oxide, the decomposed remains of a solid iron sulphide rock that contained copper. All the copper, formerly doubtless in the condition of copper sulphide, has not leached out of this gossan mass. A small amount, from 1 to 4 per cent, sometimes remains on the decomposed surface material, and in several instances has been the means of leading to the discovery of the masses of richer copper ore lying below the zone of decomposition.

Green Mountain Mines.—Situated about six miles west from Raymond, in sections 31 and 32, township 7 south, range 18 east. The owners are O. R. Sydney et al.; post office address, Le Grande. The mines have been worked at various times since 1863, and have produced large quantities of high-grade copper oxide and carbonate ores. Thousands of feet of tunnels and drifts have been run in development and for the extraction of ore. These openings, as well as the croppings of gossan, show the vein, or deposit, to be from 300 to 1200 feet in width between the inclosing walls of granodiorite on the east and diorite on the west. There is a large number of openings on the property, the most important of which are two tunnels several hundred feet in length, above which are the stopes and chambers from which the best ore has been taken and shipped. The lower or east tunnel is in 600 feet. At about 400 feet it has crosscut a vein 60 feet in width. The main body of ore lies back of this, the openings or workings of which are about 60 feet above the tunnel level, to which they are all connected by an upraise. From this upraise, several hundred feet of drifts and chambers are run in sulphide ores of good value. Thus far, no walls have been found in these workings. About 900 feet west from the above tunnel, and 50 feet above it, another tunnel has been run several hundred feet, and from it a large

quantity of carbonate and sulphide ores has been extracted and shipped.

Since Bulletin No. 23 was issued the main, or east, tunnel has been continued in an east and west drift. The west drift passes through 125 feet of ore, principally pyrrhotite, with some copper sulphide. The east drift passes through 60 feet of similar ore, showing some fine chalcopyrite, and at this point an upraise has been made to the first level, where a large body of altered sulphide has been developed and also some oxides of good grade. Overlying a portion of the sulphide body is an area of blue schist about 60 feet wide which has produced high-grade oxides and some native copper and copper glance. Most of the high-grade ore shipped in the early days came from a shaft which was subsequently lost and had been searched for in vain, until it was accidentally discovered a few years ago. A new shaft has been sunk close to it and will be connected with the tunnel. The ores of this mine, as well as those of the other mines in this district, are remarkable for being very easily oxidized, probably on account of their chemical composition and the loose, foliated structure of the gangue rock. Some of the old workings are completely coated with crystals of sulphate of copper and iron, and the intensity with which the process of oxidation is going on is proven by the high temperature in some of the stopes, which makes it impossible to work in them without ventilation. This kind of ore is called "burning ore," and it is claimed that it sometimes results in spontaneous ignition.

The western portion of this wide mineralized zone shows large croppings of gossan west of the diorite, and oxidized ores have been found in several places.

A number of buildings have been erected on the premises to accommodate a large force.

HOMESTEAD LOCATIONS ON MINERAL LAND.

On representations made by Mr. O. R. Sydney, post office Raymond, Madera County, that certain land has been taken up for alleged agricultural purposes which had been covered by mineral locations (copper) a long time before, and on which mines are situated which have produced and are still producing valuable ore, the properties involved were visited for the purpose of ascertaining the facts.

GREEN MOUNTAIN COPPER MINE, MARIPOSA COUNTY.

DUMP OF THE GREEN MOUNTAIN COPPER MINE, MARIPOSA COUNTY.

Since the discovery of the Green Mountain mine in 1863, part of which ground lies in section 3, township 8 south, range 18 east, a number of homestead claims have been taken up in the same section. In 1874 Henry Probasco, 80 acres, east No. 5668; in 1875, Jacob P. Demos, 120 acres, east No. 5959; in 1882, Elvina Bell, 120 acres, east No. 2458; in 1905, Henry I. Leonard, 40 acres, east No. 7990. This latter tract is almost entirely located on the same hill in which the Green Mountain mine is situated, and the ground it covers is entirely unfit for cultivation. The outcrop of the vein can be traced plainly into this ground, on which gossan showing copper ore and float can be found in abundance.

According to a statement made by the Surveyor General, this section has been returned as mineral land.

The land taken up by Henry L. Chapman, 160 acres in section 31, township 7 south, range 18 east, takes in part of the old Johnny Green mine, discovered in 1863, and relocated by O. R. Sydney et al., who took up the following mineral claims: Red Star, Evening Star, North Star, White Star, Star No. 2, Polar Star, and Morning Star. They sunk the shaft on the North Star claim, from 90 feet to 200 feet, and from a vein 30 feet wide shipped ore assaying 17 to 25 per cent copper and from $4 to $5 gold, and with a force of 6 or 7 men netted $1000 per month for quite awhile. A tunnel has been run about 500 feet on the east side of the mountain, and from the point where it cuts the vein a drift has been run along the latter for more than 200 feet. Near the end is a winze filled with water, which is reported to have over 5 feet of ore in the bottom. The outcrop of the vein can be traced along the hill for quite a distance.

The arable land is limited to a small, comparatively level area, surrounded by hills on three sides, through which passes a large quartz vein. Close to the dwelling house are some old workings, and it is reported that some rich ore was shipped from an old shaft now filled with water.

There are numerous and large outcrops of quartz on the hills all around this place, and a short distance east of the Green mine tunnel is the old Toad mine, which is said to have produced some rich ore.

This part of the county consists entirely of hills, which are

mostly too steep to be adapted for agricultural purposes, and with the exception of the small piece near Chapman's house, no cultivated land can be seen for a long distance in any direction.

Lone Tree Mine.—This property, situated a short distance west from the Green Mountain, with the same ownership, shows a well-defined vein of schistose rocks, or coppery gangue, about 300 feet wide, from which large quantities of carbonate ores have been extracted and shipped. This mine is opened by several shafts, varying from 25 to 100 feet in depth, all showing copper ore of good quality. The average depth below croppings, in both the Green Mountain and Lone Tree mines, to which the gossan extends, is about 100 feet. There are two distinct veins within the mineralized zone between the schistose walls, which have been traced by shallow opening for quite a distance. The main shaft is on the east vein and has reached a depth of 200 feet, with several drifts and stopes on the 150-foot level, where the oxidized ore changes into sulphides of good grade. Owner, O. R. Sydney et al.; post office Raymond, Madera County.

Cavan Mining and Milling Co.—This company's property lies in sections 4 and 5, township 8 south, range 18 east, nine and a half miles from Raymond, Madera County, and comprises 235 acres of ground, with mill site. The headquarters of the company are at Stockton. The resident superintendent and vice-president is I. C. Leonard. The development work on the property has been to the extent and on the claims specified below. The mines are all in the copper belt, are easily accessible from the railway, and are favorably located for economical work.

On the Rothchilds claim is a crosscut tunnel, which is expected to reach the vein in this claim at a depth of 250 feet, and in the Good View at a depth of 375 to 400 feet. The tunnel was in 240 feet when inspected. There is a 20-foot shaft on the south end of the Good View. This follows a streak of ore 6 to 8 inches in width, from the top of the shaft to near the bottom. There is an ore vein on the surface 20 inches wide. The ore from these streaks is said to average 15 to 25 per cent copper. The streak shows at intervals for

over 1400 feet in length. The whole width of the two claims, viz., 1200 feet, exposes layers of quartz, slate, ironstone, schist, shale, and sandstone. The main shaft was down 140 feet. The vein exposed varies from 6 inches to 6 feet in width, showing, down to 75 feet, oxidized copper ores, azurite, malachite, etc., but below 75 feet the ore is solid pyrites and chalcopyrites. Smelter returns of shipments of this ore show 31 per cent copper. There are two other shafts, down 40 and 54 feet each, showing ore of the same character as in the deep shaft, 10 to 24 inches in width from top to bottom. The vein matter is mainly diabase or meta-diabase, is 400 to 500 feet in width, and is known to be over 10,000 feet in length.

The Sunset claim has a shaft down 58 feet, showing reported values of 17 per cent ore from 10 feet below the surface to the bottom of the shaft. The ore varies from 6 to 30 inches in width. There is a schistose (diabase) foot wall and for 1000 feet a serpentine hanging wall. This serpentine at its ends changes into a brownish schistose rock. The vein matter consists of stringers of quartz, schistose, and ironstone rocks, all more or less mineralized. The ore bodies are lenticular.

On the Crown Point and Little Giant surface work has been performed.

On the Copper King there are two shafts, one 20 feet and one 50 feet deep, both showing ore from top to bottom, 6 to 30 inches in width. There is also a crosscut tunnel 65 feet long.

The San José has a crosscut tunnel 170 feet long. Three winzes from this tunnel, respectively 40, 80, and 115 feet deep, show an ore shoot 65 feet long and 4 feet wide. The 115-foot winze shows good ore from top to bottom. The ore at the bottom is 4½ feet wide. The hanging and foot walls appear to be about 700 feet apart; for that distance the same vein formation of meta-diabase (schistose rock and talcose schist), ironstone, and quartz appear, as in other places.

The Stonewall Jackson shows on the surface croppings of quartz carrying copper ore (chrysocolla) 5 feet in width, and a solid body of decomposed silicious iron from 75 to 100 feet in width.

The Cavan Mining and Milling Company's Property.—The tunnel on the Rothchilds claim is in 700 feet.

AT THE GREEN MOUNTAIN COPPER MINE, MARIPOSA COUNTY.

APEX OF HILL, LONE TREE MINE, MARIPOSA COUNTY.

The Mammoth Group, adjoining the Cavan property on the south, consists of fourteen claims, owned by O. R. Sydney. Within 600 feet there are three veins, running southeast-northwest, with a dip of 70 to 80 degrees. On the east vein there is a shaft 80 feet deep with over 6 feet of ore; on the middle vein are two shafts of 20 and 25 feet, respectively; on the west vein the shaft is 50 feet and has 3 feet of ore and reported as carrying good values in gold. It is reported that some sulphide ore of 20 to 22 per cent copper has been shipped.

Great Northern Mine.—In sections 2, 3, 10, and 11, township 7 south, range 17 east; owners, S. A. and C. R. Wilcox. There are three shafts, 25, 70, and 110 feet in depth. Cross-cuts are run from the bottom of the deepest shaft for about 40 feet. The ore body is from 1 to 8 feet in width. The vein matter is of a schistose (meta-diabase) character. The ores are green carbonates, yellow and black-blue sulphides. Wood and water are not plentiful in the immediate neighborhood. A shipment of ore was reported to have yielded 15 per cent copper and no gold.

Pocahontas Mine.—In section 14, township 7 south, range 17 east; owned by Mrs. Abbey Waller. The property consists of 160 acres of patented land, through which runs a belt of several seams, or veins, of iron ore carrying copper. The general strike of these veins is in a northeasterly direction. This belt of veins has a granodiorite east wall and a diorite west wall, and dips to the east. The vein matter is mainly diabase and altered diabase, a hard, shiny, bluish-gray rock that is frequently highly mineralized, and with its inclosures of pyrites and chalcopyrites constitutes the ore masses of these copper mines in Mariposa County. The width of the principal vein is practically 100 feet between its inclosing walls. Between the granodiorite and diorite the distance in places is over 1000 feet. The deposits of metallic sulphides, viz., iron, copper, and zinc sulphides, occur in lenses. One of these bodies being worked on the Pocahontas is known to be 50 feet long, 4 feet wide, and over 100 feet deep. It consists of a dark-colored sulphide ore, said to carry from 6 to 12 per cent of copper and $2.50 in gold. Carbonates of copper predominate down to the 100-foot level, where it all changes into

sulphides. The vein is traced through the whole length of the property and extends both ways into other properties. There are several openings on the main vein, some of which were made in the sixties. The main shaft, through which all the development is now being done and ore extracted, was over 100 feet deep, with a promising body, in size, of the best quality ore discovered in the mine. This is a dark-blue sulphide ore. Green carbonate ore has been shipped that yielded

POCAHONTAS COPPER MINE, MARIPOSA COUNTY.

35 per cent copper. Other carload shipments have given 30 per cent copper. There is on the dump over 350 tons of ore of good grade. The former lessees (Wilcox Bros.) within the three years shipped over $30,000 worth of copper ore. The adjacent country consists of low rolling hills and grazing land, is easy of access, and is twenty-four miles from Merced, and about fifteen miles from the Santa Fé Railroad.

These properties, the Great Northern and Pocahontas, are controlled since July, 1907, by the Pocahontas Copper Mining Company, office Nos. 112 and 114 Market street, San Francisco. Manager, David Ross, Lewis post office. A new shaft has

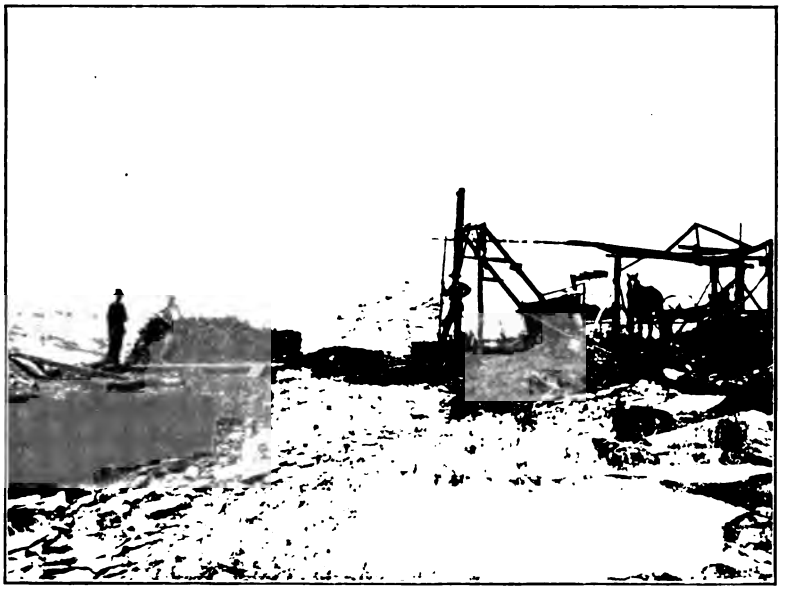
been sunk on the hillside, and a tunnel has been started at the foot of the hill which is in 340 feet. About 200 feet of vertical depth will be gained.

On the Pocahontas the main shaft on top of the hill has been sunk from 120 to 200 feet and a drift started to cut the vein, which has dipped away from the shaft within the last 25 feet. There are several old drifts above the 100-foot level from which ore has been stoped up to the surface, and below that level is a 25-foot winze sunk into a body of dark sulphide ore, which has been stoped for about 20 feet in one direction. At the 150-foot level, a drift runs 30 feet south on the vein showing over 4 feet of ore, chalcopyrite of good grade. South of the main shaft is an old 60-foot shaft, connected at the bottom with a 300-foot tunnel, starting at the southern extremity of the hill. Some good oxidized ores have been taken from shaft and tunnel and some good sulphides from a winze in the latter. Considerable improvements have been made on the surface. A steam hoist has been placed on the shaft and the necessary buildings for blacksmith shop, assay office, lodgings, office, etc., have been erected. The former owners under bond, Roberts, Higgins & Co., worked the mine six months and shipped nine carloads of ore.

A. C. Smith owns a copper mine about one and a half miles west of the Pocahontas, on patented land, in section 9, township 7 south, range 17 east, which was discovered twenty-five years ago, and has been worked on and off under lease. The vein seems identical in course, dip, and character of ore with the Great Northern, of which it apparently forms the continuation. The shaft is 80 feet deep. Charles Hill shipped a carload of ore reported to have assayed 15 per cent copper.

White Rock Copper King Mine.—In section 14, township 7 south, range 17 east. It lies about a quarter of a mile west of the contact of the granodiorite belt. The vein matter is schistose diabase, 25 feet and upward in width. There are heavy gossan croppings. Cuts, shafts, and openings in these croppings show that these decomposed masses extend downward for more than 30 feet. The main shaft is over 150 feet deep. This is equipped with a whim hoist. Development work in this shaft was in progress. Below 100 feet the ore is

WHITE ROCK, MARIPOSA COUNTY.



WHITE ROCK MINE, MARIPOSA COUNTY.

sulphide. From the shaft there are over 175 feet of drifts, all in ore. The vein channel is 100 feet wide, as shown by these drifts. Several carloads of oxide and carbonate ores were shipped, which yielded 35 per cent copper. On the dump there are several varieties of copper ore, while the bottom of the shaft is in good sulphide ore. One carload of ore was shipped that assayed over 40 per cent copper. The vein is traced southward to the Green Mountain mine, a distance of over three and a half miles, and northward for over half a mile. The ore carries from $1.50 to $2.50 in gold and 1 to 3½ ounces of silver per ton. About 100 feet to the east of the main shaft is a hole 10 feet wide, 15 feet long, and 40 feet deep, all in gossan. This gossan contains from about 4 to 7 per cent of copper. The superintendent of the property is Edwin L. Foster; post office address, Lewis. The mine was discovered in 1900. At this point the copper belt is known to be over three and a half miles wide. The property is about thirteen miles east of Le Grande, on the Santa Fé Railroad, and easily accessible. The mine, owned by the White Rock Mining Company, in Maine, has been idle for the last three years. The main shaft is said to be 160 feet deep.

Throughout the belt of country in which are the Green Mountain, Pocahontas, and White Rock mines, can be seen on almost every knoll, for a width of three or four miles, very heavy croppings of decomposed ironstone which carry copper. All of these have a general northerly and southerly trend. This character of formation, with slight modifications, extends up to and beyond Hornitos, but is particularly noticeable in the White Rock section. Another feature of the White Rock section is the frequency of strong white quartz croppings, from the principal one of which the district derives its name.

Cornett Copper Mine.—In section 19, township 6 south, range 17 east; H. W. Cornett, owner. The sulphide ore appears at the surface. The vein matter is schistose diabase, the most mineralized portion of which forms a vein 34 inches wide. The granodiorite belt is only a short distance to the east. The ore is mainly sulphide, and 160 sacks of it shipped yielded 17, 22, and 23 per cent of copper, $2.26 and $4.60 in gold. The deposit is about twenty-one miles east of Merced.

Charles Hill worked a property belonging to Dr. Pate, about five miles west, on the edge of the San Joaquin Valley.

Yosemite Copper Company.—This company, office 54 Porter Building, San José, owns a large number of claims on the road from Coulterville to Bagby, about two and a half miles from the latter place. A short tunnel run in on heavy gossan shows some heavy sulphide of iron with some copper in it, and some oxidized ores are found on the surface. A tunnel has been started some distance below, which is in 300 feet.

Lone Tree Mine.—Owned by H. W. Cornett; is in section 2, township 7 south, range 15 east. Heavy gossan croppings show in several places on the claim. The inclosing rocks are a slaty schistose diabase. The development is a shaft about 20 feet deep. This property is about seventeen miles east of Merced. The ore carries a good percentage of copper.

John Dias Mine.—In section 12, township 6 south, range 16 east. Opened by a shaft 24 feet deep. It shows a mineralized vein 3 feet wide in schistose diabase. The vein strikes northwest. The ores are red oxide, azurite, chrysocolla, and chalcopyrite. The owners shipped ore reputed to yield over $40 per ton in copper and gold.

Northward from the Dias mine, the copper belt is traced up to and beyond Indian Gulch and Hornitos by prospect holes, cuts, and minor shafts. It apparently bears off a little to the east in the same manner observed in places in counties of the State farther to the north in following the bends of the granodiorite lying to the east. After passing Hornitos, it strikes through Hunter's Valley, where there have been several important openings made and extensive mining operations carried on in years past, especially in the sixties.

La Victoria Mine.—Owned by the Coppertown Mining and Smelting Company, of San Francisco; in sections 4, 9, and 10, township 4 south, range 16 east. The company owns 7400 feet on the copper belt. The strike of the vein is in a northwesterly direction. The vein matter as explored by a tunnel is 300 feet wide; in other places it appears to be over 600 feet wide. The vein formation is schistose diabase. The character of the granodiorite east wall here is changed, resembling diorite more than granite. The ores are green carbonate, gray

copper, chalcopyrite, red oxide, azurite, and the dark bluish sulphide. Heavy gossan cappings cover all the copper ores. There is an old shaft said to be 200 feet deep in dark-colored oxide ore. A tunnel 395 feet long diagonally crosscuts the vein formation. From this tunnel ore has been breasted out to a width of over 125 feet. Besides the above main shaft and tunnel there are many open cuts, openings, crosscuts, and shafts, six of which average 75 feet deep. A belt of limestone a quarter of a mile wide runs parallel with the veins farther

LA VICTORIA MINE, MARIPOSA COUNTY.

to the west and adjacent to the vein formation. In many places the vein is blind, but the iron cappings, sometimes gossan and occasionally magnetite or black ironstone, are in line, and regular in their north and south trend. All the ores carry some gold, the gossan included. This property was owned by a French company when formerly in active operation. Three hundred men were employed in the mines, and a prosperous town of over 400 population flourished. Records show that over 2000 tons of ore were shipped via Stockton; shipping charges were $74 per ton; 2000 tons of ore were

worked on the ground by roasting and leaching, and some by smelting; 200 tons of matte were produced that carried 40 to 60 per cent of copper and from $400 to $500 in gold to the ton. This was done in 1864 and 1865, when copper values were high. The French company performed considerable development. The property is a portion of the lands owned by the Pullavincini, Dulcich, Maschio, and Enos families. The La Fayette claim is on the south end of the property.

Barretta Mine.—In sections 30 and 32, township 3 south, range 16 east; Joseph Barretta, owner. This claim was mined in the sixties. There is a shaft about 200 feet deep showing sulphide copper ore, reported to be rich in gold.

The copper belt runs hence across the Merced River, and near it appears to branch. The west belt enters Tuolumne County through the locality of the Salambo mine, in sections 30 and 32, township 2 south, range 15 east. The eastern branch passes near Piñon Blanco (Mother Lode).

Daniel Castignetto has a claim a quarter mile north of Barretta's, in section 30, township 3 south, range 16 east. It shows strong gossan croppings and a vein 20 feet wide, composed of a schistose rock. The shaft is 30 feet deep, showing decomposed red, blue, and green copper ore, and is reported to assay 6 per cent in copper and to prospect high in gold.

Farrari Brothers own a claim near by that carries a fair grade of copper ore, opened by cuts, and a shaft 50 feet deep. From this claim it is reported they have taken out $5000 in gold.

There is a claim about a quarter mile from the Chemisal House, whereon are two shafts sunk in the gossan, one 15 feet, the other 20 feet deep. Fair copper ore. Owner, Daniel Castignetto. This is in section 31, township 3 south, range 16 east.

John Barfield, in Pleasant Valley, owns the Bruschi mine, opened many years ago by shafts, cuts, and tunnels. The claim runs to the Merced River, in township 3 south, range 15 east.

Between Barfield's and Hornitos there are copper croppings somewhat prospected, especially at about halfway between the two places on Phillips Flat.

From Barfield's, across the river to the north, are croppings,

and on Antone Rihn's ranch, in section 13, township 3 south, range 15 east, there are shafts 60 and 40 feet deep, respectively, showing chalcopyrite, besides decomposed copper ore. On the Halstead place there are croppings and a shaft 30 feet deep, showing copper ore. The vein is 4 to 6 feet wide. The croppings are copper-stained schistose rock.

At Flyaway, about five miles southeast of Coulterville, on the county road to Bear Valley, is a claim having a shaft 75 feet deep, with drifts at bottom. The croppings of the vein are 7 feet wide. It is in the serpentine belt that traverses the country hereabouts. In the shaft the vein, carrying copper, averages 12 feet wide. The copper content has always been neglected, and the ore worked only for gold. It is reported that about $75,000 in gold has been taken from pockets in the mine. The owner is G. Commissiona.

In the eastern portion of the county there are indications of extensive deposits of copper ore, which have never been worked to any considerable extent. The Minaret, on King Creek, a west branch of the Little San Joaquin, on the south shoulder of Mount Lyell, exhibits strongly impregnated copper rocks. There is no development, however, to show the extent or value of the deposits.

On the north fork of Chowchilla Creek, in section 34, township 6 south, range 19 east, at Indian Peak, considerable prospecting was done by Mr. Ward, of Grub Gulch. Considerable native copper is found in the ores.

Copper Queen Mine.—P. Stanton and J. J. Trabucco own a claim in section 19, township 5 south, range 19 east. It is east of the Mother Lode and about three and a half miles east of the town of Mariposa. The vein strikes northwest. A shaft has been sunk 40 feet, and an incline 15 feet deep shows a vein over 4 feet wide in a schistose formation. The ore is green carbonate on top, with blue sulphide below; some is very high grade, carrying massive native copper.

George Heiser owns an adjoining claim, showing similar ore, with shaft 30 feet deep. The values reported are from 19 to 37 per cent in copper. There is an abundance of timber surrounding the last two properties.

Copper in slate and quartz is occasionally found in localities adjacent to the Mother Lode, and on the east side of it, along

its course, but such occurrences have never proved to have any economic value.

There is a minor spur from the copper belt proper in the southwestern corner of the county in section 30, township 8 south, range 18 east. Not much prospecting has been done upon it.

MADERA COUNTY.

The foothill copper belt maintains in Madera County the importance, promise, and characteristics it displays in Mariposa County to the north. At various points through this county it exhibits strong copper-bearing veins, frequently carrying good values in gold. Here, too, were some of the important early attempts at copper mining and smelting. Before 1866, the Buchanan mine, near the northern boundary, was operated with the aid of a small furnace, and 150 tons of copper bars had been shipped. This county has also been the scene of later attempts at mining and reduction of copper ores by the California Copper Company, though temporary failure has marked the attempt. Several copper properties have been undergoing development.

Madera County differs from its northern neighbors of the Sierra Nevada mineral belt in reaching westward past the foothills to the center of the great San Joaquin Valley, and so including in its area a large section of that fertile plain. It mainly lies on the slope, however, reaching to the summit line of the range, and possessing a wealth of minerals, forests, and waters. Though the Mother Lode and the auriferous slate belt of the slope terminate just to its north, the county includes a rich section of the Sierra auriferous belt, but the multitudinous quartz veins are in granite and other formations. There are several important gold mining districts in the county, including Grub Gulch, Fine Gold, Fresno, Potter's Ridge, and others, and a number of important mines have been developed, yet the county has been strangely neglected and its mineral resources are but slightly developed or even known.

High in the Sierras, by the Minaret Mountains, are rich silver-bearing veins, and one of the largest and richest deposits

of iron ore in the United States. Difficulty of access and other conditions have kept them undeveloped.

Among other mineral resources of the county is granite. The granite quarry at Raymond is one of the largest and most active in the west. The foothill mineral belt crosses the county from Mariposa to Fresno, maintaining its southeasterly course and its relative position on the slope.

Buchanan Mine.—Close to the northern boundary of Madera County, but a little south of the Green Mountain mine, in Mariposa County, is the old Buchanan mine. It is in section 33, township 8 south, range 18 east, and is owned by G. A. Pherson. Five miles southwest is Daulton, on the branch railroad to Raymond. The mine is opened by five tunnels, respectively 500, 120, 100, 60, and 30 feet in length. There are also two shafts, each about 200 feet deep. The vein matter is diabase and amphibolite schist, both mineralized. The east wall of the diabase dike is granodiorite. The ores are principally oxides near the surface. In depth they are the unaltered sulphides. There are three winzes below the 500-foot tunnel, which show the four veins from 4 to 9 feet wide. The large dumps show that extensive work has been done in times past, since the discovery of the deposits in the early sixties. What ore can be seen appears to be good both in quantity and quality. The mine is near the railroad.

On the line southeast toward the Daulton ranch house there are several openings on the belt consisting of old and new shafts, cuts, and tunnels, whereby one is enabled to trace the course of the belt unerringly.

The mine has been worked by the United States Copper Smelting and Mining Company, under bond. With one exception, the old tunnels are partly caved in and are no longer in use, and a new shaft has been started below the old one near the foot of the hill about 200 feet east of the vein. It is 200 feet deep and a drift runs from the bottom in a westerly direction, intended to cut the vein dipping towards it within about a hundred feet. The shaft is equipped with steam hoist, air compressor, and the necessary accessory buildings. The principal vein has been traced along the slope of the hill for some distance, its strike bearing north 15 degrees west, with a dip of 70 degrees towards the east. Several small

BUCHANAN COPPER MINE, MADERA COUNTY.

ore seams of little importance are found east of this vein with a course parallel to it. Part of the mine was worked under lease by Mr. Van Timmens, who worked the main vein through a tunnel over 200 feet long, 1100 feet north of the shaft. A winze was sunk in a drift at the end of the tunnel on the vein from 2 to 4 feet wide, carrying a black sulphide with chalcopyrite. The ore was reported to assay 15 per cent copper, $4 in gold, and 12 ounces of silver.

Joe Wagner Mine.—The Joe Wagner mine is situated in section 2, township 8 south, range 18 east, and section 35, township 9 south, range 18 east, on land patented January 10, 1863; owner, Caesar Vignola, Raymond. About one and a half miles due east from the Buchanan. Formation, schist; vein, southwest-northeast. Old shaft full of water, about 100 feet east of it is a shaft 25 feet deep; dry, but inaccessible. Old shaft said to be 80 feet deep; one drift in bottom; one 30 feet from surface, and said to have produced some copper ore. Very little evidence of copper ore, except a few pieces of oxide copper ore, mostly malachite, on the dump. Has been idle many years. The property is distant from Raymond about six miles.

Copper Queen Mine.—In section 15, township 9 south, range 18 east, two and a half miles north of the Daulton house. Mr. Allinger bonded the property and sank a shaft in the same formation as at the Buchanan and in the Daulton mines, and obtaining the same class of ore. Owner, the Daulton estate.

West of the old Daulton schoolhouse a short distance are several old shafts, showing copper ores, oxides and sulphides.

On the northern part of the Daulton ranch there are several good copper prospects.

California Copper Co.—This is a New York corporation which bought the Ne Plus Ultra and other claims on the Daulton ranch, near the railroad, in section 35, township 9 south, range 18 east. The mine was developed and a 100-ton smelter was erected at Madera, twelve miles distant, in 1899-1900. After four months of smelting, the smelter and mine closed down in June, 1900, and have since been idle. The claims are opened by three shafts and equipped with steam hoists. The depths of the shafts are respectively 200, 200, and 120 feet. Besides these, there is

CALIFORNIA COPPER COMPANY'S PROPERTY, DAULTON RANCH, MADERA COUNTY.

another shaft on the Nelson claim 100 feet deep, equipped with a whim. The vein matter is in places 200 feet wide. The more condensed areas of mineralization are about 60 feet in width. The formation is diabase, which in places changes to talcose schist. Granodiorite lies to the east, as is usual on this belt. The ores are carbonates, oxides, and sulphides. The two former overlie the latter, and are in lens-shaped bunches. There are gossan croppings capping the ore bodies. The strike of the vein is northeast; the dip is to the east. Large quantities of ore have been extracted, shipped, and smelted. The three hoists surmount the summit of a low hill, around whose base are grouped the various mine buildings, such as bunk houses, store, offices, shops, dwellings, etc.

The smelting plant of the company is located at Madera, twelve miles west from the mines. The ore was transported to Madera by teams, from which point it was shipped by rail to one of the acid works on San Francisco Bay. The sulphur was there extracted and the cinders returned to Madera, where they were mixed with a certain proportion of raw ore and smelted into matte. This process was continued for about four months, when the smelter was shut down. While in blast the company shipped on an average one carload of matte per day. The smelter is of 100 tons daily capacity.

The property of this company has been transferred to the California and Nevada Copper Company, of New York; Walter C. Brace, manager; I. N. Baker, superintendent. The width of the ore bodies varies from 9 to 40 feet, and the average is reported to be 3 per cent copper, 28 per cent sulphur, 40 per cent iron, $4 in gold, and 1 ounce of silver. On an assay chart of somewhat remote date several drifts are marked as being in 5 and 12 per cent ore. The smelter has remained idle ever since it was shut down.

Questo Mine.—This is the south extension of the Daulton, and is owned by Mr. Greenwood. The vein matter is meta-diabase. The ore occurs in lenses. Considerable work has been performed upon it.

The copper belt extends south of Daulton to the San Joaquin River, the county's southern boundary. It can be traced along this interval and its course proven by croppings, cuts, and shallow shafts. Near the Fresno River it disappears, but

CALIFORNIA COPPER COMPANY'S SMELTER AT MADERA.

reappears farther southward. From a point ten or twelve miles directly east of Madera copper-stained rock appears continuously into Fresno County. The formation in which the masses of iron and copper sulphides occur is practically the same, viz., a meta-diabase. The granodiorite follows along as an east wall.

In sections 23 and 26, township 10 south, range 19 east, on patented land owned by Mrs. L. Krohn, J. H. Ward developed under bond an old claim which was originally taken up for gold. Good copper ore and indications of a deposit were observed.

Adobe Ranch.—The croppings lead into what is known as the Adobe ranch, owner C. S. Moses, in township 10 south, range 19 east, comprising thirty-five sections of land, and nine miles south of Daulton. There are several places on the ranch where 30 per cent copper ore is said to have been taken out.

One local peculiarity of the belt in Madera County is the presence of graphite in seams and bunches within the copper belt.

At the Fresno River there are several old shafts, the dumps of which show copper ore. The belt bears off easterly and crosses the San Joaquin at Pollasky, which is in township 11 south, range 21 east.

On the Chowchilla River, in the northern part of the county, in township 7 south, range 19 east, there is quite an extensive copper deposit, which C. M. Ward prospected. The ores developed are oxides and carbonates.

Three miles east of Bellview, in section 16, township 10 south, range 21 east, off the copper belt, is what is known as the Old Reed mine, which carries some copper in its ores.

Big Chief.—This claim, owned by M. Lauer et al., is on the east bank of Fine Gold Creek, in section 23, township 10 south, range 21 east, in the Hildreth mining district, on the south side of the county. Considerable development has been performed on a series of three ledges, 2 to 8 feet wide. Here the smaller veins are of quartz, in a schistose vein matter of extensive width. One tunnel is in 46 feet. There is a shallow shaft 10 feet deep. The greater part of the work is against the face of the bluff, where the veins are exposed. The copper ores are sulphides, oxides, and green carbonate, and it is said that they carry values of $4 to $5 in gold per ton.

FRESNO COUNTY.

About 30 miles of the foothill copper belt measures the narrowest part of the large and important county of Fresno, which stretches from the crest of the Sierra Nevada range for nearly 150 miles down the Sierra slope, across the San Joaquin Valley, and up the eastern slope of the Coast Range to its summit. It thus naturally displays a very great diversification of physical features, conditions, and resources. The rugged and well timbered and watered Sierra slope, nearly 60 miles wide from range summit to valley plain, is extensively mineralized, but its mineral resources have been but slightly exploited. Gold quartz veins are plentiful along a wide belt, and several mining districts are well known, but the gold product is yet small. In few counties does the inaccessible and unexplored base-ore belt of the high Sierras display more inviting surface indications. Below these great areas is the foothill mineral belt.

The varied mineral resources of the county that have been developed are mainly in the lower foothills of both ranges. The chief feature of these resources is the petroleum of the famous Coalinga oil field on the western side of the valley, the product of which in 1907 was 9,050,300 barrels. Near this oil field are extensive coal beds, which were at one time mined. Silver, antimony, iron, bismuth, chrome, magnesite, building stone, and mineral waters are among the existent mineral products awaiting utilization. The Sierra slope is well watered by the San Joaquin and Kings rivers and their tributaries. The great stretch of valley plain is wonderfully fertile under irrigation, and its fruits have chiefly given the county its fame. Here is the great raisin district of the State. One of the important electric transmission plants of the State finds its source of energy in a Sierra stream.

The foothill copper belt, as it enters the county from Madera on the north, displays a greater width than in any of the other counties traversed by the belt from its far northern end. The copper deposits that have undergone any development worthy of note are all near the northern side of this part of the

county, and are chiefly in township 12 south, ranges 21, 22, 23, and 24 east, Mount Diablo meridian. The belt here appears to display parallel lodes, spread over a width of perhaps twenty miles, and is generally taken by those locally familiar with it to divide into two branches in this region, these widely diverging branches continuing separately on through Fresno and Tulare counties. The property best known, by reason of its operations and its large capitalization, is the Copper King, which has been extensively developed. Most of the other properties commanding attention as prospects are within a few miles of the Copper King. A branch railroad to Pollasky runs within a few miles of this copper district near the northern side of the county. Most of the cupriferous veins of Fresno County carry gold, as do those in Madera and Mariposa to the north. Far east of the belt, and high in the Sierras, at altitudes of several thousand feet, are various mining claims covering veins superficially rich in copper and gold; but, like the rest of the mineral riches of this vast region, they await the more favorable conditions that time will bring to an almost inaccessible country.

Painter Mine.—This property, by the northern boundary, near Pollasky, in section 33, township 11 south, range 21 east, is owned by the Imperial Copper Mining Company. The course of the vein is 23 degrees north of west. There are gossan croppings 1 to 20 feet wide. The vein matter is metadiabase, changing in some places to talcose schist. The country rock is diabase and amphibolite schist. The vein followed in the workings is from 4 to 7 feet wide. The mine was reopened in 1900. The development consists of one shaft 110 feet deep, equipped with a horse-whim, which shaft follows oxidized ores for 100 feet, and then encounters the sulphides. An inclined shaft 80 feet deep follows the hanging wall. This shaft has drifts and crosscuts from it, with total lengths of 160 feet. Another shaft has been sunk 50 feet in carbonate ore. There is an open cut 6 or 7 feet deep, made in 1866, that follows the vein about 50 feet, and shows good appearing oxidized ores. The known length of ore shoot disclosed by the above openings is 750 feet. In places in the mine there are found lumps of very rich ore ("nigger heads"), inclosed in talc. From the

first shaft drifts extend both east and west for 45 feet, making a total drift length of 90 feet. Several hundred tons of ore have been extracted and shipped, and is said to have yielded an average of 15 per cent copper. The copper belt at this point is two miles wide. The Painter mine is on the east side and the Heiskell mine on the west side of the belt. There are a few buildings on the property, such as assay office, boarding and bunk houses, barn, etc.

Fresno Copper Mines.—This group, formerly known as the Heiskell, consisting of five full claims, was owned by H. B. Vercoe et al., H. G. Vercoe superintendent, and is in section 10, township 12 south, range 21 east. The course of the vein is north and south, width 18 feet. There are heavy gossan croppings. The gossan extends downward about 50 feet. Below these gossan caps are bluish-black sulphides. The mines are opened by shafts, two of 200 feet each in depth, one of 50 feet, one of 45 feet, and one of 35 feet. Six men were employed. The ores are carbonates and oxides above and sulphides below, and the average assay value of the ore was stated to be 7 per cent copper and $2 in gold.

Since the publication of Bulletin No. 23 these mines have become the property of the Fresno Copper Company, Ltd., of Glasgow, Scotland, which has increased by purchase of adjoining property the area of its possessions to more than 2000 acres. The company made extensive improvements on the ground, consisting of hoist and pump for the main shaft, air compressor, electric light plant, sawmill, machine shop, assay office, the necessary buildings for offices and residences, and a copper smelter. Steam furnishes the power for hoist and air compressor. The pump, electric light plant, sawmill, and workshop are operated by electricity furnished by the San Joaquin Power Company. The smelting plant consists of three essential parts: the furnaces, the converter shed, and the power house. The two furnaces, each of 200 tons capacity, are of the round type, built of brick, lined with chrome iron brick, and fitted with heavy air pipes for hot blast. An iron floor extends around and between the furnaces, a little below where the iron cone-shaped covering commences, which has a large round opening at the top for introducing the charge, there being no feed doors. Each furnace has alongside of it

a cylindrical dust chamber of sheet iron, with a smokestack of the same material attached. On one side stand three large cylindrical air chambers, made of iron and lined with fire brick, with a stove for heating the air. All of these structures stand on a cement foundation, elevated about 12 feet above the ground, with a railroad track immediately in front and across it a level space for bedding the ores and a bin for receiving the ready mixed charges. A movable derrick running on the track, was intended to carry the ores from the bedding floor to the bins. From each furnace an iron frame extends to the

FRESNO COPPER MINE, FRESNO COUNTY.

ore bin, containing a wire cable, by means of which an iron bucket filled with the ore charge is lifted to the top and discharged through the aperture in its center. The converter house (an open iron shed) contains three converters of the Leghorn type, with all the necessary apparatus; a car fitted with an iron box, lined with fire brick and heated with oil, for conveying the matte from the furnaces, slag pots, and molds for receiving the metal. The motive power for furnaces and converters is supplied from a building situated between them, where a 500-horsepower engine drives a large piston blower for the furnace blast, a smaller one for the converter and a pumping machine to produce hydraulic pressure for the opera-

tion of the moving gear of the latter. A railroad had been surveyed to the nearest point on the Fresno-Pollasky branch, three miles distant, and before the roadbed was finished a locomotive and several ore cars were ordered and delivered at the mine. This smelter has never been in operation to any greater extent than the starting of a fire in the air heater and a trial run of the machinery, which revealed a serious defect in its construction. After the plant was completed, it was discovered that the ore, of which there were thousands of tons on the dump and exposed in the mine, was too low grade for treatment, and the company decided to confine operations at present to the exploration of the mine, hoping to find better ore at greater depth, the prospect work being carried on under the management of C. C. Leavitt. The mine is situated in the western copper belt, in a low hill on the edge of the San Joaquin Valley, and there is no gossan or any other indication of ore outside of it in the immediate neighborhood. The ore occurs in schistose rock, partly micaceous, with strata of dark, fine-grained rock resembling diabase. Near the surface, extending only to little depth, some rich ores had been found and were smelted on the ground, as shown by a small pile of slag, but at what time and by whom this was done is not known. Three veins are known within the wide mineralized zone, one east and one west of the main vein, but except the latter, they have not been explored below the gossan. The main shaft is 530 feet deep. Drifts on the 200 and 300-foot levels expose a solid body of sulphide ore, principally pyrrhotite, extending 400 feet along the course of the vein, attaining a width of over 50 feet in places (averaging 14 feet in thickness), and of unknown extent downwards. This ore was supposed to average at least 7 per cent copper and appreciable values in gold, but when it was sampled *after the smelter had been completed* and was ready to be started, the astonishing fact became known that it assayed only 2 per cent copper and practically no gold. On the 300-foot level a cross vein, 2 to 4 feet wide, has been discovered and followed a short distance by a drift, which carries galena, iron pyrites, zinc-blende, and good values in silver. Small streaks of chalcopyrite appeared in the lower workings.

Copper King Mine.—This mine is in section 3, township 12 south, range 23 east. It was owned by the Copper King Mining Company, Ltd., of London, of which W. H. Daily was the general manager. The property consists of one mining claim, 1500 by 600 feet, with all necessary buildings thereon. The vein courses northeast and southwest. The vein matter appears to have a width of over 100 feet. It is schistose and meta-diabase in its composition, all mineralized. The lenses of ore consist of carbonates, oxides, and sulphides of iron and copper. The sulphides obtain to the exclusion of the others in the deeper workings of the mine. This was opened by three shafts, the deepest of which was used for operating purposes and the others for ventilation only. The first named shaft is 450 feet deep. Altogether there are six levels driven from the operating shaft, with total lengths of over 2500 feet. The usual granodiorite belt bounds the copper belt to the east and diorite lies to the west.

The smelter of the Copper King, Limited, at Seal Bluff Landing, on Suisun Bay, forty miles from San Francisco, was called the Pacific Coast Smelting and Refining Works. Besides treating the ore from the company's mine in Fresno County, copper ores were sought and received from many sources. After running the smelter for awhile, the company failed, and the property went into the hands of a receiver. While the smelter remained closed, the mine was worked in the interest of the creditors in charge of C. C. Leavitt, under whose management it paid a large amount of money from a 16-foot vein of chalcopyrite, averaging 8 per cent copper. In June, 1907, the property was sold by order of the court and bought by the Hart Mining Company of Fresno, for nearly $45,000, which started work in July, and is said to have taken out more than that value in a few months. The main shaft has reached a depth of nearly 800 feet and the other incline a depth of about 700 feet.

The two properties, the Copper King and the Fresno mine, promoted by the same party, present interesting examples of faulty mining operations, if nothing worse; but this is not the place to make an attempt to draw the delicate line between unintentional and intentional mistakes (frauds), or to fix the responsibility upon any definite individual. It is sufficient to state the facts and let the reader draw his own conclusions.

MINING PLANT OF THE COPPER KING MINING COMPANY, LIMITED, FRESNO COUNTY.

The Copper King consists of one claim only, and at the time when the smelter was built, the deepest shaft had reached 450 feet only. Although the vein was wide, 19 feet in places, and the ore of fair grade, it does not seem probable that a careful estimate of the ore in sight would have shown sufficient values to justify the erection of a smelter which cost $700,000, according to a statement by Herbert Lang in the "Engineering and Mining Journal," of November 30, 1907. The company having failed, the property passed into the hands of a receiver, and was worked from 1905 until 1906 for the creditors, in charge of C. C. Leavitt, and sold in June, 1907, to the Hart Mining Company, of Fresno, which continued operations for several months and took out, according to reliable information, more than the purchase money, which amounted to $44,000. The ore taken out for the creditors was not treated in the company's own works, but sold to another smelter and netted a large sum, which seems to be sufficient proof that the mine would have paid under competent management. According to Herbert Lang's statement, the mine could have paid at least $400,000 clear profit with economical management.

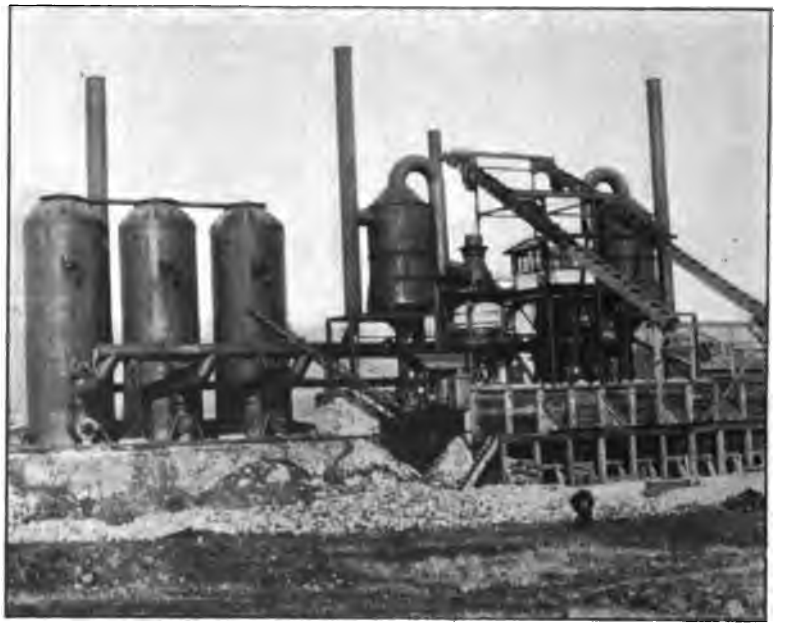
The case of the Fresno mine is somewhat different. Leaving out of consideration the limited quantity of oxidized ores near the surface, the mine never had ore of sufficient grade to justify the erection of a smelter on the premises; but it is evident that the company was not aware of this fact, for no person of sane mind would invest money in an enterprise knowing for certain that it must be a failure.

In Herbert Lang's article occurs the following interesting passage: "The lens upon which the major part of the development has been done gave promise at first of carrying good values, but after the long deferred sampling had been performed, it was found that its sulphide portion contained on the average hardly 2 per cent copper." The expression "long deferred sampling" implies the idea that the company had not sampled and tested the ore before, and was actually in ignorance about its values and character all the time while the smelter was being built. With thousands of tons of ore on the dump and exposed in the drifts of the mine, such a supposition seems incredible, and it seems more probable, as stated by well informed parties, that the company firmly

SHIPPING STATION OF COPPER KING, LIMITED, AT DEERING, ON S. P. R. R.

SMELTER OF THE COPPER KING, LIMITED, AT SEAL BLUFF LANDING, CONTRA COSTA COUNTY.

believed the ore averaged 7 per cent copper and carried appreciable values in gold besides. When the smelter was completed, a metallurgist was engaged to run it. He sampled the ore, found it to average scarcely 2 per cent copper, and sent in his resignation with this report. Then two experts were sent to sample the mine, and when they confirmed the low-grade character of the ore no further attempt was made to start the



SMELTER AT FRESNO MINE, FRESNO COUNTY.

smelter. It is a remarkable circumstance that Mr. Lang was likewise ignorant of the character of the ore, for otherwise he could not have advised the company to put up a plant which cost about half a million dollars. But whatever may have been the circumstances and conditions, the erection of the smelter was a blunder which could easily have been avoided and for which there was no excuse. Some one has been guilty of gross negligence, if nothing worse.

Something might be said about the type and arrangement of the smelter, but such technical questions are irrelevant to the main point at issue; the great mistake was to put it up in a place where it ought not to be.

Wabash Mining Co.—This company has located ground surrounding the Copper King mine on all sides. There are two shafts on this property, one about 40 feet deep, on which the owners made preparations to erect hoisting machinery. The other shaft is over 30 feet deep. One tunnel has been run over 400 feet, and another 300 feet. The vein formation is similar to that of the Copper King. These mines are in sections 2, 3, 10, and 11, township 12 south, range 23 east, and are owned by Dr. Bryant and others of Los Angeles.

Mount Sterling.—Owned by Kneiper & Ashbrook, and adjoining the Wabash ground on the south, in section 10, township 12 south, range 23 east. On this property the owners drove a tunnel to cut the ledge, which is mineralized, carrying iron and copper sulphides.

Grubstake Claim.—Owned by C. H. Kneiper and Mr. Taylor; adjoins the Mount Sterling, and shows similar copper ore. Southward, the indications of copper ore continue to Kings River.

Black Mountain Claim.—In section 36, township 11 south, range 23 east, one and a half miles northeast of the Copper King; owned by W. S. Cranmer. It is on patented land. The vein is in limestone (calc spar), and averages about 3 feet in width. This ore is said to carry 15 to 19 per cent copper and $5 in gold per ton. The openings comprise a shaft 30 feet deep, a tunnel run in a northeasterly direction along the course of the vein for 60 feet, and another tunnel 20 feet below the first named, following the vein for 180 feet. The vein splits and has decidedly branching tendencies. At the mouth of the 180-foot tunnel there is a shaft 30 feet deep in ore. A third tunnel, intended to strike the vein 100 feet below the bottom of this 30-foot shaft, has been started. It is now in 125 feet. Open cuts and shallow holes on the surface discover the same quality of ore wherever they have been sunk. The ore is oxide and sulphide of good appearance. The east wall is a gray diabase, associated with talc schist.

Buck's Peak Claim.—Two miles south of Black Mountain; owned by W. S. Cranmer. Shows two veins, 30 feet apart,

one of which is one foot wide and the other three feet wide. A shaft 12 feet deep on the 3-foot vein shows green carbonate of copper ore for the whole width of the vein.

Sunset Mine.—In section 35, township 11 south, range 23 east; owners, D. S. Snodgrass et al. There are gossan croppings. The ledge matter is 60 feet wide. The ore is of about the same character as that in the Copper King, and consists of carbonates and sulphides. There is a shaft 90 feet deep, with crosscut at its bottom 60 feet long, all in ore, which is said to average 10 per cent copper and to carry about $14 in gold per ton. The vein matter is schistose diabase. A belt of limestone occurs in the east side.

A. L. Hildebrand has locations on both the north and south ends of the Sunset claim. On these locations are croppings of the same character as on the Sunset.

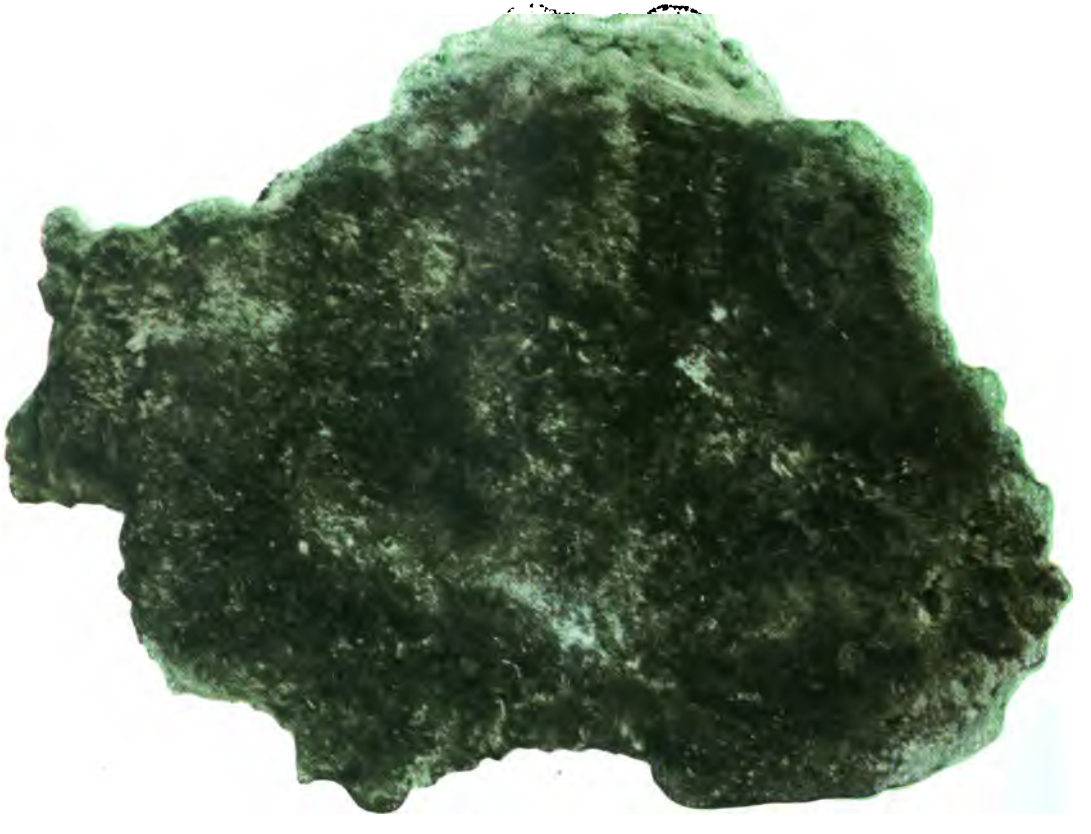
Henry Wineberger has locations on the northwest side of Hildebrand's claim, on which there are indications of copper.

Happy Camp Claim.—Three and a half miles east of the Copper King mine. There is a tunnel 135 feet long, with crosscut at end 17 feet long from wall to wall. The ore is decomposed quartz, said to carry 4 per cent copper and $10 in gold.

W. L. Hinkle & Bros. have some claims in sections 25, 26, and 27, township 12 south, range 24 east, that show copper ore in talcose schist. There are several other prospects near by, which yield copper minerals.

Anderson & Gist own fifteen claims on Hog Mountain, one and a half miles west of Trimmer Springs, in sections 14, 15, 23, and 24, township 12 south, range 24 east. Across the river east of Trimmer Springs, Mr. Terrill of Visalia is working ten claims in sections 16 and 17 on the copper belt, with some favorable prospects. These claims are in township 12 south, range 24 east. There are heavy iron gossan croppings on the property.

In Kings River Canyon, high in the Sierras, in sections 9 and 10, township 13 south, range 31 east, there are indications of copper deposits. George Badders & Co. are now working seven claims, in which they find some very good oxide and



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hide ores. They had opened a shaft 30 feet deep, but not ıgh development work had been performed to determine extent or value of these deposits. The vein matter is ·tly quartz.

.'. A. Kanawyer & Sons own a group of eight claims in ·tion 11, township 13 south, range 31 east. The vein matter quartz, with granodiorite walls. The vein shows 6 to 15 et in width, and is traced for two miles. It carries, accord-ıg to information, over 10 per cent copper and $11 in gold. 'here are open cuts and a perpendicular cliff 100 feet high; he cliff shows the vein in its face. The prospect is thirty-six niles from Millwood.

TULARE COUNTY.

A large area of the Sierra slope is comprised within the bounds of Tulare County, the eastern boundary of which runs for about 75 miles along the range summit and the western portion of which embraces a fertile and favored section of the San Joaquin Valley. In this county, in the Sierra foothills, is one of the important orange districts of California, and here, also in the valley plain below, are extensive orchards and vineyards as well as many great grain ranches. This is one of the minor mineral counties of the State, though it has extensive mineral resources awaiting the future.

In this county, the copper belt displays but occasional indications of its presence, has been but little explored and only slightly developed. The branches into which the belt divides in Fresno County appear to be prolonged with increasing divergence through Tulare County. The western branch is the most clearly defined, and is characterized by narrow diverging seams or stringers of copper-bearing minerals. Just east of Porterville, there is an area of country fully five miles wide, in which these small veins occur. Like the eastern branch this one is extensively hidden by detrital deposits, and outcrops only at intervals. This west branch appears to lose its identity and disappear near Kernville, in Kern County, to

the south. The east branch of the belt swings easterly and mounts to an altitude of over 5000 feet. The chief deposits identified with this east branch are near the middle of the county, thirty miles or so east of Porterville and the west belt, and amid the forest region, where some of the chief sequoia groves of the State are found. Copper prospects of possible future value occur high in the Sierras, notably some described below, located close to Kearsarge Peak in the extreme northeastern corner of the county, above the timber line and at an altitude of 10,000 to 12,000 feet.

W. F. Powell owns some claims in the east branch of the copper belt, located in section 30, township 19 south, range 31 east, on the middle fork of Tule River, thirty miles east of Porterville, at an altitude of about 5500 feet. The mineralized zone is said to be 300 feet wide, and can be traced by surface croppings for more than six miles in a northerly direction. There are three tunnels, one cross-cutting the mineralized rock for 150 feet, without reaching a wall. The course of the vein is northeast and southwest. The copper ores are yellow and black sulphides, carrying 3 to 4 per cent copper. Occasionally, however, small quantities of native copper are found. The vein matter lies between a limestone east wall and a serpentine west wall.

W. F. Grider has a claim two miles east of the Enterprise sawmill, in section 31, township 19 south, range 31 east. Some test lots of ore have been shipped.

C. W. Keller owns claims near Powell's in the same township and range. The vein matter is reported to be not less than 70 feet wide on any of these claims. A lime belt 4 to 100 feet wide intersects the copper lode near these places. The copper belt crops out again strongly five miles above Three Rivers, and there are several locations on this part of the belt.

East of Porterville, ten miles, in section 14, township 23 south, range 28 east, Dr. Barber, of Porterville, prospected what proved to be a blanket, or slide, of ore reported as carrying 8 to 37 per cent copper.

Dr. Barber also has a claim located eight miles east of Porterville, in section 19, township 21 south, range 29 east.

COPPER MOUNTAIN MINING COMPANY'S CLAIMS, TULARE COUNTY.

Here there is a heavy iron capping, and the vein appears to be 20 to 30 feet wide. Below the iron cap carbonate and oxide of copper ore is found. The formation is diabase and amphibolite schist. The gold content is reported at from $3 to $4 per ton.

Dewey Claim.—Owned by J. F. Boller, of Porterville, is in section 32, township 19 south, range 31 east. Only a small amount of development has been performed. This exposes sulphide ore.

On the hillside east of Porterville is an abundance of small pieces of copper float, which doubtless came from the five-mile belt of small stringer veins.

Copper Mountain Mining Co.—Owns fifty claims in sections 34 and 35, township 14 south, range 31 east, near Kearsarge Peak, close to the crest of the range. R. McCourt is superintendent, and J. B. Campbell, of Fresno, president. The mines were opened in July, 1900. The ores are sulphides and carbonates, carrying from 2 to 25 per cent of copper. The mineral-bearing belt is a mile wide, and courses northeast and southwest. The deposit in the richer veins of this belt is opened by a shaft 18 feet deep, a tunnel 5 feet long, and an open cut 50 feet long, on the east side of Roaring River. On the west side there is an old shaft and drift.

At the head of Cloudy River Canyon, close to the Copper Mountain property, there are some cuts, and a tunnel 40 feet long. Quartz shows strongly in this tunnel. The decomposed ironstone carries gold. The old shaft shows a 3-foot ledge of carbonate ore. The vein matter is schist, diabase, and amphibolite. The claims are 1000 feet above the timber line. A dike about 3000 feet wide passes through the summits of the mountains. This dike is of mineralized rock.

A few miles east of Lindsay the foothills of the Sierra rise abruptly from the plain to a height of about 900 feet, presenting smooth lines and rounded summits. The formation is schist, serpentine, and granite porphyry. They are separated by Lewis Creek from the adjacent hills on the north, which are composed entirely of granite and present a very broken and rugged appearance.

In 1905, A. W. Sherman, post office Lindsay, found some copper on the southern slope of a hill and located the Blue Crystal quartz mine, one claim, non-patented. A small vein in serpentine, running southwest-northeast, carried oxidized ores with a little bornite and chalcopyrite. The workings consist of an open cut and a tunnel of about 75 feet, from which some ore was taken. So far, no shipment has been made, but it is stated that a sample assayed 39 per cent copper, $32 gold, $15 silver. Broad bands of massive Vesuvianite or Californite have been encountered in the workings.

On the northern slope of the same hill the Gill mine has been located in schist and altered porphyritic rock. An open cut and tunnel, together about 90 feet in length, shows a 2-foot vein running southwest-northeast, carrying some oxidized ores.

KERN COUNTY.

The foothill copper belt terminates in a vague way in Kern County, where a few groups of copper deposits cut a small figure among the varied mineral products of a great mining county. This is one of the large counties of the State, having an area of about 8100 square miles, and it is characterized by greater variety and contrasts of topography, geology, climate, and resources than any other California county.

Its eastern and southern parts contain the southern end of the Sierra Nevada range and its mergence with the Coast Range at Tehachapi. Its western boundary is along the summit of the Coast Range, and the upper end of the San Joaquin Valley makes up about one third of the county's area. The southeastern slope of the Sierras and a large portion of the Mojave Desert are included in its southern part. The county thus includes slopes of two mountain ranges, a large and fertile valley plain, and an arid desert region. All of these contrasted regions contain much mineral wealth. On the Sierra slope, amid forests and waters, are important quartz mining districts. In the valley plain, near Bakersfield, is the

remarkable and widely known Kern River oil-field. On the eastern slope of the Coast Range are the Sunset and McKittrick oil-fields, which help make Kern the preëminent petroleum-producing county of California. The foothills of both these ranges abound in various minerals, including gypsum and antimony. In the desert region of the county is the Randsburg district, one of the chief gold fields of the State, and other gold districts are undergoing development on the desert side of the Sierras. The mineral output of the county in 1907 was $6,092,606, of which $878,798 was in gold. In the San Joaquin Valley are extensive orchards and the largest irrigation systems in the State. The Kern River, of the Sierra slope, furnishes power for one of the important electric power transmission plants of the State.

The copper occurrences are so few and widely separated, as far as discovered, that one is hardly warranted in identifying them with the copper belt, except in the most general way. The continuity of the belt is less apparent than in any of the counties of the slope to the north. Copper deposits have attracted attention principally in three localities: Near Woody and quite a distance east near Kernville, on the western Sierra slope; in the Rademacher mining district, on the southeastern slope of the Sierras; and on the northern edge of the Mojave Desert, north of Randsburg. In the neighborhood of Walker's Pass, between Kernville and the Rademacher district, copper minerals are found, and the copper claims of the latter district may, perhaps, be appropriately classed with the Sierra Nevada deposits rather than with those of the arid portion of Southern California.

Greenback Copper Mine.—Located in northern Kern County, about thirty-five miles by wagon road from Bakersfield and about eighteen miles due east of Jasmin on the Porterville branch of the Southern Pacific Railroad. The property of the Greenback Copper Company consists of sections 1 and 3, and the southern part of section 2, township 26 south, range 29 east, embracing in all 1520 acres. The mine lies on a slight elevation in a basin, the rock forming which is granodiorite. The granite is intersected by a parallel system of joints or fractures, which usually trend approximately east

and west. In addition, there are very abundant dikes of a white, fine-grained granite (aplite) in the coarse granite or granodiorite. They are from a fraction of an inch to 10 feet in width. There are also white, coarse, pegmatite dikes, or veins in the granite, and some of these are developed sporadically as bunches of white quartz ("bull" quartz). Copper has been found at a number of points in the neighborhood, and the lodes are usually more or less parallel to the structure planes of the inclosing rocks, but this is not the case with the

GREENBACK COPPER MINE, KERN COUNTY.

Greenback lode, the general trend of which is across the east-west fracture system of the granodiorite. About one mile southwest of the mine lies a high east-west ridge known as Iron Mountain. The upper part of this ridge is composed of a variety of rocks, some of which strongly resemble quartzite, but the slopes of the mountain are all of granite rocks. There are several cuts and shafts on the top of the mountain in the hard quartzite-like rock, but no strong indications of copper appear to have been found, except on the north slope, just

west of the line of section 3, and on the south slope of the east end of the mountain, where some work has been done on a copper lode. Several claims are located on this lode. At most of the points where copper has been found, the lode at the surface is composed of a gossan of rusty iron-stained material, often apparently rotten granite, generally somewhat gneissic and not always showing copper carbonate. The croppings of the Greenback lode consist of altered granite, decomposed, and impregnated with iron oxide and at some points with copper carbonate, and there is more or less quartz mixed with it. The Greenback lode has been opened by a shaft which inclines to the north about 60 degrees, and from this shaft three levels have been run to the north. The upper part of the main ore shoot is composed of carbonate ore, and has not been stoped out; but from a point about 65 feet below the croppings to a point 170 feet below, this ore shoot has afforded ore that has been shipped, the reported average contents being 5.7 ounces of silver and 19.4 per cent of copper per ton. As seen in the cross-section, the ore shoot is lenticular in form, with a maximum width of about 20 feet. Outside of this ore shoot the granite is irregularly impregnated with copper pyrite, so that there is a much larger amount of lower grade ore in the mine than of shipping ore. The Greenback lode does not appear to show any well-defined fissure. While there are walls and seams along which movement has taken place, and these usually have a trend to the east of north, yet these walls and seams appear to dip both to the east and west at high angles. As indicated by the croppings, the lode may be said to have a length of perhaps 350 feet measured from the south base of the dump to the old shaft on the top of the hill.

A. J. Maltby owns two claims in sections 4 and 10, township 26 south, range 29 east. Here there are gossan croppings and schistose-diabase vein matter, as well as talcose schist. There are open cuts exposing ore. Two shafts, 16 and 35 feet deep, are in ore. There has been shipped some ore said to average about 6 per cent in copper and a small amount of gold.

The Spa and Bonanza claims, in sections 3, 4, 9, and 10, township 26 south, range 29 east, show copper ore reported to average from 15 to 20 per cent. There are four shafts on

these claims. On section 9 heavy ironstone croppings can be traced for considerable distances.

South of Kernville, in township 26 south, range 23 east, J. L. Hooper is making developments that show some copper.

J. R. Manning of Randsburg is one of the owners of a group of copper claims in sections 7, 18, 19, and 30, township 28 south, range 40 east, and in sections 12, 13, and 24, township 28 south, range 39 east, in the Rademacher district near the eastern county boundary, in the Mojave Desert. The belt here is one and a half miles wide. Granodiorite lies contiguous to the east, and on the west there is a lime belt. The lode is formed of a mineralized meta-diabase schistose, changed in part to talcose schist. The seams of richer copper ore run from 2 to 12 inches in width, and where they form lenses or "shoots" they have widths occasionally of 60 feet. These lenses of highly mineralized rock constituting the ore carry a good percentage of copper.

Near the Manning claims is the Gallow Glass group, in which the gossan croppings are 60 to 100 feet wide and the magnetite from 5 to 15 feet wide. There are thirty-seven mining locations on this part of the belt. There are several open cuts, one shaft 54 feet deep, and fourteen other shafts. The belt can be traced by croppings and cuts for four miles in a northwesterly direction to where it disappears under the detritus of the desert. The line of demarcation between the lime and copper belts can be noted for miles.

The road from Randsburg to the south fork of the Kern River through Walker's Pass diagonally crosses the copper belt, which also crops in township 27 south, ranges 38 and 39 east.

SOUTHERN AND EASTERN DEPOSITS.

MONO COUNTY.

About 100 miles of the eastern slope of the Sierra Nevada range stretches through Mono County, which lies between the jagged crest of the Sierras on the west, Nevada on the east, and Alpine and Inyo counties on the north and south, respectively. The county displays high ranges parallel with the Sierras and is a part of the Great Basin. The county is a rugged, arid, almost treeless region, remote from railroad communication, except in the southeastern corner, which is traversed by the Carson & Colorado Railroad. Mono Lake, which has no outlet, is a large expanse of saline waters. There are many thermal springs, and widespread evidences of volcanic and glacial action.

The county is richly mineralized, and has produced many millions in the precious metals. In 1907 it yielded $18,574 in gold and $29,797 in silver. It has a number of well-known mining districts, particularly the famous Bodie district, in which quite extensive mining operations have been conducted in the past; but the conditions above noted, the base character of the ores, and some large mining failures, consequent on incompetent or dishonest administration, have worked a long repression of the industry. The extent and richness of the mineralized veins make it certain that the future will see Mono one of the leading mineral-producing counties of the State. The base ores that fill the mountain slopes very frequently carry copper in association with other minerals, and some attempts at mining copper have been made in the past and abandoned. One small copper smelting plant produced $60,000 worth of ingot copper many years ago. Only two copper properties attract present attention as such. They are on Copper Mountain 16 miles southwest of Bodie, and about 4 miles from the west shore of Mono Lake. The nearest rail-

road station is 60 miles from Copper Mountain, at Hawthorne, Nevada, on the Carson & Colorado Railroad.

Santiago, Cuba, and Havana Claims.—Owned by E. M. Cavin, of Bodie. Located on Copper Mountain. They have been developed to some extent by a 150-foot shaft, showing good ore, and by about 500 feet of tunneling, but this last work was not done to advantage. The deposit is found on the contact of limestone and porphyry. The ore is principally cuprite and malachite. The width of the deposit has not been determined. A small furnace was once erected and some ore treated. Water power is available, and there is an abundance of timber in the region.

Goleta Consolidated Mines.—The Goleta mines are also on Copper Mountain. Hugh W. Nelson, of Jordan, is superintendent. This group is primarily a gold mine, but there is in it a copper ledge which is exposed on the hanging wall side of the gold ledge. Developments have exposed a vein of copper ore averaging 6 feet in width, the ore appearing to be chrysocolla. There is a tunnel 200 feet on the vein, tapping it 300 feet below the outcrop. The mines are worked only for the gold and silver. The ore is treated by the cyanide process, a 40-stamp mill being used to crush the ore. Water power is used.

INYO COUNTY.

Inyo County is a great and picturesque expanse, 10,000 square miles in extent, lying between the summit of the Sierras on the west, Nevada on the east, Mono County on the north, and San Bernardino County on the south. On its western boundary rises Mount Whitney (14,515 feet), the highest peak in the United States proper, and about 75 miles eastward lies Death Valley, the lowest part of which is more than 400 feet below sea-level. At the foot of the Sierra range is Owens Lake, fed by Owens River and having no outlet. Soda is largely produced from the waters of this lake. Practically all

the arable land is comprised in a strip of bottom land, 2 to 3 miles wide, through Owens River Valley, which has a width of 8 to 10 miles. The Carson & Colorado Railroad, running southward to Keeler on Owens Lake in the west-central part of the county, largely relieves the handicap of remoteness from which the county suffers.

Lack of fuel, water, facilities for communication, and convenient sources of supply join with an unfavorable climate to repress the mining industry generally throughout the southwestern desert region, but the great extent and frequent richness of the mineral resources of Inyo County have made it one of the important mining counties of the State since early days. The Panamint, Argus, and Inyo ranges and some lesser ones run parallel with the Sierras through the southern part of the county, and from the ledges that fill them the bulk of the $12,000,000 worth of precious metals Inyo has produced has come. Some of the rich mines of the west were operated in various well-known districts years ago. The ores of this region are base and a large percentage of silver accompanies the gold, while lead, copper, and other metals are also characteristically associated with the precious metals. This county has been the chief silver producer of the State, and the drop in the price of silver was the main cause of the quietude of the mining industry here in recent years. During the past few years much active development has followed several large investments, and here as elsewhere through that desert region, prospectors have turned numerously to a field full of great possibilities. The provision of railroad facilities through the southern portion of the county will afford another great stimulus to mining activity, as heretofore only high-grade ores could be worked. In Death Valley is one of the chief borax fields of the United States. Marble of fine quality is among the mineral resources awaiting favorable conditions, and extensive deposits of nitrate of soda have been found.

There are numerous occurrences of copper, generally in association with greater values in other metals, but it is occasionally the predominating metal in ore bodies. Some copper ore carrying gold and silver was smelted to matte and shipped via the Colorado River in early times, but the copper output

has been small. With cheaper fuel and transportation facilities modern smelting plants will be established in this region and then copper will likely again figure in Inyo's mineral output.

Wisconsin Claim.—This prospect is located about a mile southeast of Darwin, and is owned by Charles Richardson of Darwin. The vein is a contact between limestone and granite. The ledge varies from 2 to 6 feet in thickness and is exposed on the surface for several hundred feet. There is a shaft about 150 feet deep, with good ore in the bottom. The ledge shows malachite, chalcopyrite, and cuprite, carrying some gold and silver. The nearest point to a railroad is Keeler, twenty-four miles distant.

Kingman Claim.—James McDonald of Darwin, owner. There are two claims located one mile southeast of Darwin. The ledge is a contact vein between limestone and granite, and the average width of the vein is about 3 feet. There are two tunnels, each in about a hundred feet. The ledge shows malachite, chalcopyrite, and cuprite, carrying some gold and silver.

THE UBEHEBE DISTRICT.

The Ubehebe district is located east by north from Keeler, the terminus of the Carson & Colorado Railroad on Owens Lake, about 35 miles distant. It comprises approximately an area of about 15 miles long, and nearly as wide, bounded on the west by Saline Valley, on the south by spurs of the Inyo range extending to the mountains on Hunter's ranch; on the east by the continuation of the Panamint range, and on the north by hills extending from Saline Valley to Lost Valley, the northern continuation of Death Valley. Most of this territory is occupied by two mountains, the Ubehebe and the Dutton range, the former on the west, running south and north for about 8 miles, forming the eastern boundary of the Saline Valley; the latter on the east, running parallel with it and attaining about the same elevation, 5000 feet above sea level. Both are separated by a valley, a couple of miles wide, the greater part of which is occupied by a dry lake bed, perfectly level and formed of hard clay, and called the "Race Track." During the winter it is sometimes covered by shallow water, seldom more than a foot deep.

FORMATION.

The mountains are composed of granite, quartzite, and lime, with occasional dikes of porphyritic and dioritic rocks. Granite is predominating. It occurs in great masses along the western slope of the Ubehebe mountain; forms the entire mountain in its central part and the highest peaks. Quartzite and lime are prominent at the southern and northern extremities, and some of the hills are entirely composed of either of these rocks or of both combined. The quartzite is very massive; the lime contains magnesia and is either of yellowish color with a sandy grain, or of a bluish color, resembling closely the Leadville dolomite. No fossils have been found, but from the position of the rocks, the quartzite overlying the archæan and the lime the quartzite, it seems safe to consider them palaeozoic rocks of the Cambrian and Silurian ages.

ORES.

The ores are mostly found in the limestone, usually on the contact with the granite or close to it. It is an interesting fact that the veins generally do not lie directly on the contact, but are separated from the granite by a dike of igneous rock, a granitic porphyry, diorite or quartz-porphyry, which may have played an important part in the mineralization of the contact. The ores are principally oxides of copper, malachite, azurite, chrysocolla, and cuprite, and occasionally some sulphides, especially chalcocite, of which handsome specimens have been found. A few veins carry gold as the principal value, and recently some silver-lead ores have been discovered. On the whole the surface ores are of a good grade, and compare favorably with ores from camps that have lately attracted much attention. The gangue rock consists of the usual material, silicious iron, jasper or chert, quartz, calcite, and in places garnet rock, epidote, pyroxene, etc. The veins are generally wide and can often be traced for hundreds of feet on the surface. No ore has been found on the lime and quartzite, and quartzite and granite contact.

FACILITIES FOR WORKING THE MINES.

The Ubehebe district has been known for more than thirty years, the first location being made at the time when the Cerro

Gordo mine in the Inyo range, near Keeler, was in a prosperous condition. But the mines did not pay, work was suspended, and they have been idle ever since, until recently, when the great interest taken in copper induced some parties to take hold of some of the old properties and commence development work. The same difficulties peculiar to most of the desert camps, lack of water, wood, and transportation facilities, which proved insurmountable in the olden times, still exist, but not in the same degree, and can be easier overcome by improved mechanical appliances, while the high price of copper permits of greater expenditure for its production. Water is found 6 miles distant from Ubehebe Mountain, in Grapevine and Dodd's springs, and small streams are found in the canyons after heavy snows and might be utilized. A new spring has been lately opened on Tin Mountain in the Dutton range, about 6 miles from the new camp of Ubehebe or Saline. Although the distance to the railroad at Keeler is not great, only a little over 20 miles in a straight line, it is of little advantage for the camp because there is no wagon road to the station, and practically it has been in communication with the railroad only since the completion of the new line from Tonopah to Bullfrog. A wagon road has been built from Ubehebe through Lost Valley (which is here 2000 feet above sea level) and the Grapevine range to the small station Montana, a short distance from the old Thorpe mill. By trail the distance to Keeler and Darwin is about 35 miles, the wagon road to Montana 50 miles. There is another wagon road from Alvord through the Inyo range and Saline Valley, but it is a long distance and particularly disagreeable in summer time on account of the great heat in that valley.

The Valentine Group of fourteen claims, situated about halfway between Keeler and Ubehebe, has several veins between granite and lime, reported to assay 2½ to 16 per cent copper, 9 to 14 ounces of silver, and a little gold. The copper bullion has over 50 feet sulphide in lime, said to assay 4 per cent copper. Owners, I. Anthony and D. Pobst, Lone Pine, Cal.

Navajo Chief Claim.—Owners, W. T. Grant of Olancha and George McConnell of Independence. It is located one quarter of a mile south of Dodd's Springs. Elevation, 4000 feet. The

vein outcrops for about 1000 feet, showing an average width of 50 feet, and with a strike north; dip 80 degrees east. The hanging wall is limestone and the foot wall granite. The ore is chiefly malachite, carrying some gold and silver. There is sufficient water for mining purposes. The nearest railroad point is Keeler, thirty miles distant.

Eureka Claim.—Owned by Jacob Stininger; post office address, Tule Canyon, California. It is located one eighth of a mile south of Dodd's Springs; elevation, 3500 feet. The strike of the vein is north, and dip 60 degrees to the east. The croppings show a length of 150 feet, and an average width of 5 feet. There is an 80-foot shaft and 100 feet of drifts on the vein. The ore is malachite and shows some galena.

Trail Claim.—Owners, W. T. Grant of Olancha and George McConnell, of Independence. It is located at Dodd's Springs; elevation, 3900 feet. The vein has a strike north; dip 70 degrees to the east. It outcrops about 800 feet, and shows an average width of 5 feet.

Dodd's Springs Claim.—Owned by W. T. Grant of Olancha and George McConnell of Independence. This mine is located on the same ledge as the Trail claim. It outcrops for 1000 feet and shows a vein about 15 feet wide. The character of the ore is malachite.

Ulida Group.—This group includes eight prospects: The Ulida, Sorbia, Sardine, H. M. Stanley, Kabba Riga, Virginia, Maryland, and Hunter, located in the Dutton range, three miles north of Hunter Ranch Mountain, and thirty-five miles east of Keeler. Elevation, 6000 feet. The nearest water is three miles distant, and could be obtained by gravity. All of the veins are contacts between limestone and granite. The ore, which occurs mostly in the limestone, is malachite, tetrahedrite, and cuprite, carrying gold and silver. Immense outcroppings, varying from 10 to 20 feet in width and showing malachite, are exposed.

At the Ulida there is a tunnel 150 feet on the vein, and another tunnel above, 150 feet long, runs for 40 feet on the vein. There has been some stoping done, and about 400 tons of ore are on the dump. The ore is sorted, packed out on mules seven miles to a road, then hauled to Keeler and shipped

CROPPINGS OF COPPER KING MINE, UBEHEBE DISTRICT, INYO COUNTY.

COPPER CROPPINGS AT DODD'S SPRINGS, UBEHEBE DISTRICT, INYO COUNTY.

to the smelter. Owners, Spear Bros. and William L. Hunter; post office address, Lone Pine, Inyo County. The Ulida is one of the oldest claims in the district.

Adjoining the Ulida group on the northeast are the Keeler, the Olancha, and the Spear, owned by McConnell & Spear. The outcroppings are similar to those of the Ulida group.

Copper Knife.—Located a quarter of a mile east of the Randolph race track; owners, W. T. Grant of Olancha and George McConnell of Independence. The ledge outcrops about 800 feet, and shows a width of 10 feet. The ore is malachite.

Anton & Pobst Claims.—These mines include five claims, located sixteen miles east of Keeler. The claims show outcroppings 100 feet wide, 800 feet in length, on the strike of the vein. The ore is chiefly malachite. There is a tunnel about 20 feet long, in good ore. Owners, John Anton and David Pobst, of Lone Pine, Cal.

Silver Hill.—This claim is located seven miles east of Independence, and one half mile from the Carson & Colorado Railroad; elevation, 4500 feet. Owner, J. C. Roeper, of Independence. There is a 70-foot tunnel, showing a 2½-foot vein of malachite. The vein is a contact between granite and limestone. There is plenty of water for mining and reduction purposes.

Green Monster.—Owner, D. C. Riddell, of Gilroy, Cal. This is a continuation of the Silver Hill prospect. Development consists of a 300-foot tunnel and two crosscuts, one 80 feet and the other 50 feet. Some good copper ore has been exposed.

Copper Tail.—J. C. Roeper, owner. This claim adjoins the Green Monster. It has a 40-foot shaft in the ore body. The ledge is 4 feet wide at the surface, but pinches at the bottom of the shaft.

Copper Point.—Owner, Max Fausel; located one mile northeast of the Green Monster. It has a 10-foot shaft in good ore. The vein shows a width of 2 feet, and an outcrop of about 500 feet on the surface. It is a contact vein between granite and limestone. The ore is malachite.

The Inyo Copper Mines and Smelter Company.—By far the most important exploration work in the district has been done by this company, whose property consists of nineteen

INYO COPPER SMELTING AND MINING COMPANY, UBEHEBE DISTRICT, INYO COUNTY.

claims, located in the lime and quartzite formation at the southern extremity of Ubehebe Mountain. On twelve claims, having an area of 240 acres, ore has been found reported as assaying from 4 per cent to 41 per cent copper, and carrying small quantities of silver and gold.

Excelsior.—A vein is found in the lime not far from the contact, about 20 feet wide, strike southeast-northwest, dip about 65 degrees; ore, oxides, reported as assaying from 2 to 16 per cent copper. A 70-foot shaft cuts the vein and continues in the foot wall. No crosscutting has yet been done. At about 400 feet south another opening has been made, showing strongly copper-stained gangue rock.

Fairbury.—Shows a vein about 6 feet wide, with lime for a foot and diorite for a hanging wall; strike east and west; dip about 50 degrees north. Shaft of 40 feet passes through vein; no crosscutting yet. Ore reported as assaying 3 to 11 per cent copper.

Fairbanks No. 4.—A 30-foot open cut and tunnel runs across the contact, but does not show the full width of the vein, which runs east and west. Several streaks of ore, principally malachite, with some sulphide, are found, one about 2 feet wide, reported as assaying 37 to 41 per cent copper, a few ounces of silver, and a little gold.

Ormonde.—An open cut of 35 feet crosses mineralized zone between lime hanging and diorite foot wall; strike northeast and southwest; dip about 50 degrees south; 5 feet reported as assaying 5 to 30 per cent copper. A 9-foot shaft a short distance from the cut shows several feet of vein matter with some sulphides.

Ormonde No. 2.—Shows several veins of 3 to 4 feet in limestone; strike north and south; dip about 60 degrees west; reported as assaying 8 per cent copper. A tunnel 50 feet in is run to cut the vein.

Kenilworth No. 1.—Has vein on contact between lime and diorite. In a few small holes ore reported as assaying 7 per cent copper was found.

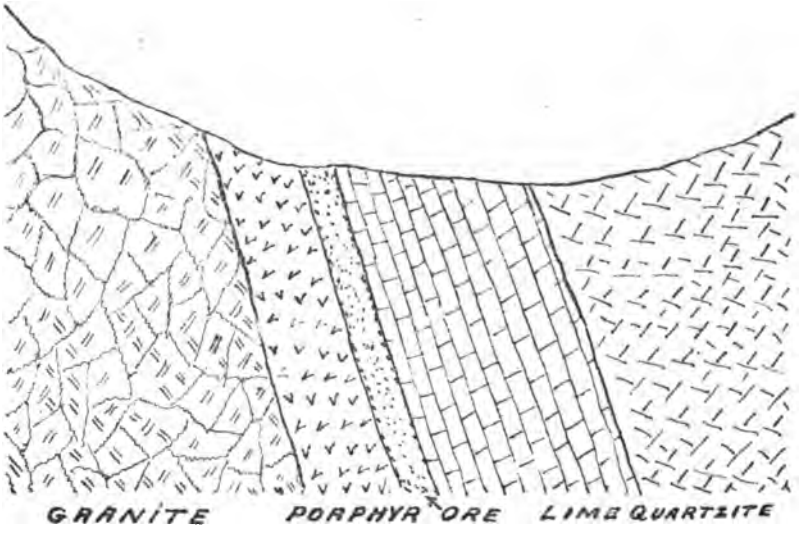
Kenilworth No. 2.—A cut of 15 feet and a tunnel of 45 feet have been run on a 4-foot vein, with granite foot and lime

hanging wall standing almost vertical. Ore reported as assaying 8 per cent copper.

Pluton.—Shows vein in open cut of 30 feet, running nearly north and east; continuation of Ormonde vein; reported as assaying 7 per cent copper.

Ajax.—Open cut 15 feet; shaft 12 feet, with over a foot of ore; reported as assaying 6 per cent copper.

On the rest of the claims but little work has been done.



CROSS-SECTION OF PROPERTY OF THE INYO COPPER MINING AND SMELTING COMPANY, UBEHEBE DISTRICT, INYO COUNTY.

Some of them look promising, showing a continuation of contacts in which ore has been found in other places. Manager, R. G. Paddock, Keeler.

At the northern end of the Ubehebe Mountain are located some of the older claims, on which work has lately been resumed. The Sanger group consists of:

The Tip Top.—Thirty-five feet of tunnel on granite-lime contact; 6 to 8 feet of ore.

Star.—The prospect is located at the base of the Ubehebe Mountain; the strike of the vein is north. There is a 60-foot cut, 6 feet deep, showing malachite. The ore outcrops 800 feet on the strike and shows a width of 60 feet.

Copper King.—It is located one mile west of the Star; owner, W. A. Sanger, Big Pine. The ledge shows on the surface a width of 100 feet and a length of 700 feet. There is a shaft 60 feet deep and a 20-foot drift, showing malachite.

The Prince Group.—Four claims. Crosscut 60 feet, showing oxides and some native copper; owned by W. A. Sanger & Son, Big Pine, Cal.

Bluejay.—Owned by A. Mairs, of Independence. It is located on the east side of Saline Valley. The outcroppings show a ledge 60 feet wide, and may be traced 500 feet on the surface. There is a tunnel in 100 feet, a winze 35 feet deep, and a crosscut 25 feet. The ore is malachite and chalcocite.

The Red Bird.—Showing some native copper. F. A. Mears, Big Pine.

Good Luck Group.—Three and a half claims on diorite dike, showing copper sulphides and some oxides. R. Lockhardt & Penrod, Rhyolite.

In the southern part of the Ubehebe Mountain a lead-silver vein, running north and south, has been recently discovered in the lime on the Wedding Stake claim, and a small copper vein, with a strike southeast and northwest; ore reported assaying 35 per cent copper, 103 ounces of silver, and a little gold, on the Red Bear, both owned by J. H. Crook and Sam Baysdon, Keeler.

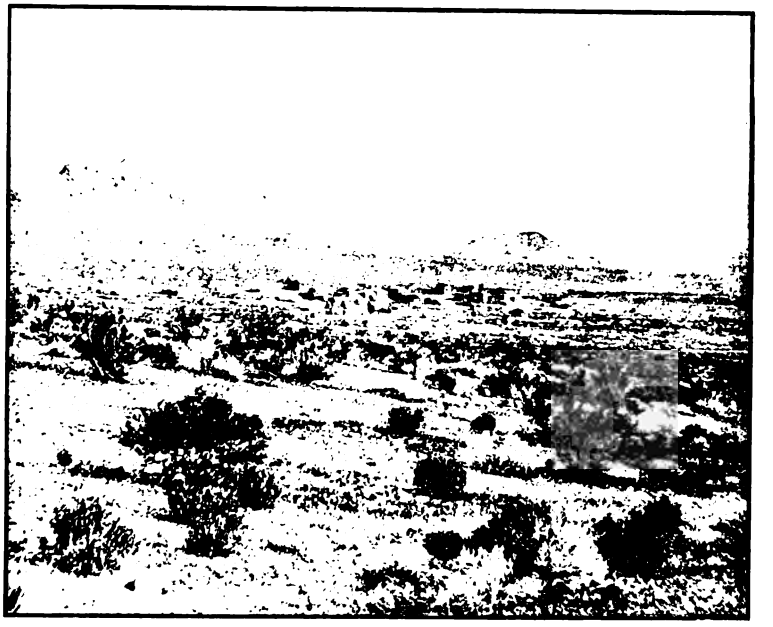
Several claims have been located on surface indications by Roberts & Derat, and Woodin & McConnell.

Some gold and copper have been discovered on the eastern slope of Tin Mountain, in the Dutton range, on the Lake View claim, owned by W. D. Blackman, Rhyolite.

W. Scott and Mr. Titus have located twelve claims not far from Dobb's Spring, the ore carrying gold, silver, lead, and some copper, called the Scott group.

The Sanger Group is controlled by John Salsbury, of Tonopah, who established the new camp called Saline town.

Some locations have been made on the western slope of the Inyo range, about five miles north of Keeler, in a formation consisting principally of phonolyte of a slaty or schistose structure, very much broken up, at an elevation of from 6100



DARWIN LOOKING SOUTH, ARGUS RANGE IN DISTANCE.

SMELTING PLANT AND HOIST OF LANE MINE, DARWIN, INYO COUNTY.

to 6500 feet above sea level. The veins have a course of southwest and northwest; dip almost vertical; a gangue rock of quartz with a little lime; ore mostly oxidized, with some sulphides, copper glance, etc.

The Rainbow Claim is owned by L. Boshart, and the Horseshoe claim by Joe Anselowitch, Keeler post office.

DARWIN.

Darwin is situated north of 36 degrees latitude, in township 19 south, range 40 east, at the foot of the western slope of a spur of the Argus range, which forms its northern extremity and is separated from its main part by the Darwin Canyon, through which the drainage of Coso Valley passes into Panamint Valley. About ten miles to the west are the Coso Mountains, the valley of the same name lying between them and the Argus range, and being separated in the north from the Owens Lake Basin by a chain of low hills. The elevation of the town is 4746 feet, that of the highest point of the spur 6190 feet. The formation is limestone, overlying granite, penetrated by numerous dikes of porphyritic rocks and diorite. At the contact with these igneous rocks, the lime appears greatly altered, the blue color changes into white, the texture becomes crystalline, marble-like, and the increased hardness indicates a partial silicification.

The veins are found in the contact or in the lime close to the contact, seldom in the igneous rocks, and, so far, never in the granite. They seem to have been formed by replacement, the vein matter consisting of quartz and massive lime spar, carrying galena, carbonate of lead, silver, a little gold, oxides of iron and copper, but seldom their sulphides. Only one fossil has been found in the lime, apparently an orthoceras, which would indicate lower carboniferous, perhaps upper silurian.

Forty years ago Darwin was an important mining camp, producing ore enough to keep several smelters in operation. The mines were worked only for their values in lead, gold, and silver, and with the gradually declining price of the latter metal, and the decrease in the grade of ore, they were shut down one after the other and the camp became almost deserted.

No attempt was made to utilize the copper ores until 1898, when a smelter was built at the Lane mine, which, after a brief but successful campaign, in which it is said to have produced $17,000 worth of copper matte, shut down permanently. Quite recently, the copper prospects began to attract attention, and the work of exploration has already commenced. Some of the old mines will resume operations, and, to all appearances, the camp will enter a new era of activity.

The camp has a good supply of water, and is distant from the nearest railroad station, Keeler, only 25 miles. Most of the ores near Darwin carry a little copper, and there are numerous outcrops of copper veins on which not enough work has been done to determine the details, size, dip, etc. They occur usually in lime, on or near the contact with igneous rock, run east and west, or north and south, with a steep dip, varying in width from 3 to 6 feet, occasionally increasing to several times this measure. The ores are mostly oxidized, malachite, chrysocolla, and seldom azurite and cuprite, occasionally sulphides and little lead. All the mines are located in the spur north of Darwin Canyon, within an area of about 4 to 6 miles.

The Giroux Group, Rio Tinto; section 24, township 19 south, range 40 east, nine claims. In a lime ledge, overlying diorite, are several copper veins of which three have been exposed within about 150 feet, running east and west and dipping south into the hill at a steep angle. A shaft has been sunk in the diorite foot wall 203 feet, and a crosscut run from its bottom to the lime 95 feet, where work was stopped. The outcrop can be traced along the hillsides for several thousand feet, and a number of holes sunk in it show copper through the entire distance. Owner, Joseph Giroux, Los Angeles.

Richardson Group.—Eight claims in section 24, township 19 south, range 40 east. A shaft was sunk 103 feet on a 4-foot vein in the Alameda claim, and a great deal of ore was extracted.

On another claim in the same group, a 100-foot tunnel following a silver-bearing vein, cut through a vein carrying copper, which has not been explored. Owner, I. E. Ridgeway, Darwin.

Custer Mine.—In section 24, township 19 south, range 40 east, a large vein, running east and west, and which can be traced for several hundred feet, has been partly opened by an open cut, showing a face of over 10 feet of ore. In a 120-foot tunnel below the vein has not been reached. Owners, Gorman & Anthony, Independence.

In the same township and range are the following claims:

Climax.—Two veins, east and west; one vein, north and south; copper, silver, lead, gold. J. W. Clark, Darwin.

Winchester Group.—Five claims, three copper veins. Sam Brooks, Independence, owner.

Verde.—Copper, lead, silver. Inyo Copper Company, Darwin.

Argo and Arrowhead Claims.—Three claims; copper. Inyo Copper Company, Darwin.

Keystone.—Extension of Giroux vein. Long & Clark, Darwin, owners.

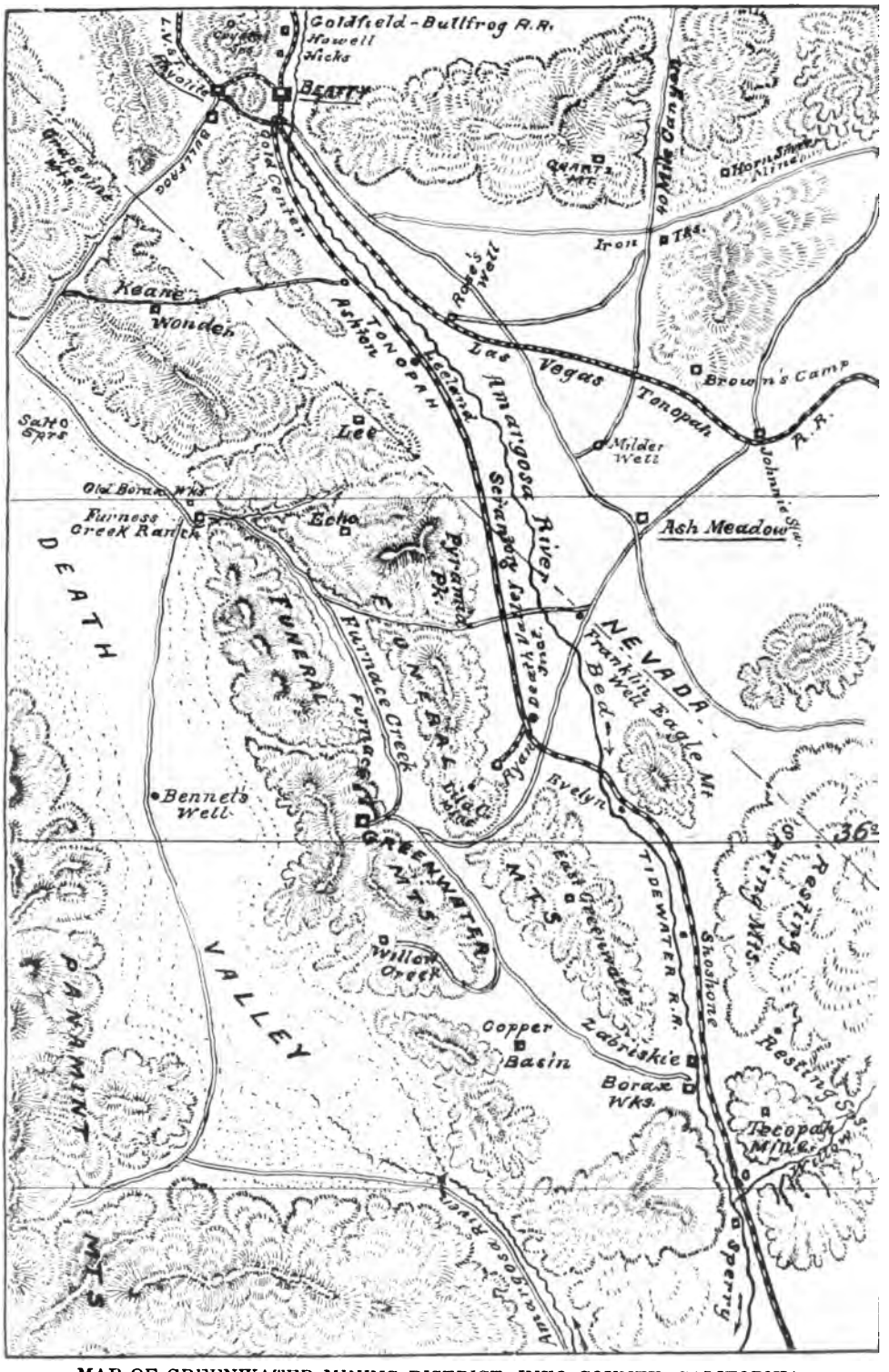
Copper Alta.—Copper. Porter Bros., Darwin, owners.

Windy Group.—Three claims; copper, silver, lead. Clark & Long, owners.

Madox Group.—Eleven claims; copper, silver, lead. John Adams, Darwin, owner.

All the old mines to which Darwin owed its prosperity forty years ago, the Independence, Defiance, Lucky Jim, Promontory, Liberty and Columbia, Jackass and Lane, carry a little copper, or have separate veins on their ground that have been neglected, with the exception of the last named. The Lane mine has one shaft of 700 feet and one incline of 500 feet, from both of which copper ore was taken, and smelted into matte, but the ore gave out at 550 feet, in the deep shaft, and mine and smelter were shut down.

References: Jul. A. Luck, E.M.; A. Held, assayer and chemist; J. W. Clark and John Adams, of Darwin.



MAP OF GREENWATER MINING DISTRICT, INYO COUNTY, CALIFORNIA.

BONANZA GREENWATER COPPER CO.

This property is situated in the old Resting Springs mining district, Inyo County, California, six miles easterly from Willow Creek, and about ten miles westerly from the Tonopah and Tidewater Railroad. The names of the claims owned by this company are the Bonanza and Bonanza No. 1. The general formation of this section is lime and porphyry, the ledges occurring both as contact and fissure veins. The main ledge on these two claims varies from 12 to 80 feet in width and over 3000 feet in length. In many respects they are the most remarkable croppings discovered since 1849. The ore bodies rise above the ground to a height of 20 feet, solid bodies of cerrusite. A shipment made of these croppings taken wholly from above the surface gave a reported return of $21.82 per ton, gold $4.94, silver $1.23, and lead $15.24, with some iron.

The ore lying next to the porphyry wall carries gold and lead values, and the ore next to the lime wall carries gold, silver, lead and copper values. A reported offer from the same smelting company for the next shipment taken from the part of the ledge nearest the lime wall was given as gold $2.66, silver $1.23, lead $27.80, and copper $29.90, a total of $57.82 per ton.

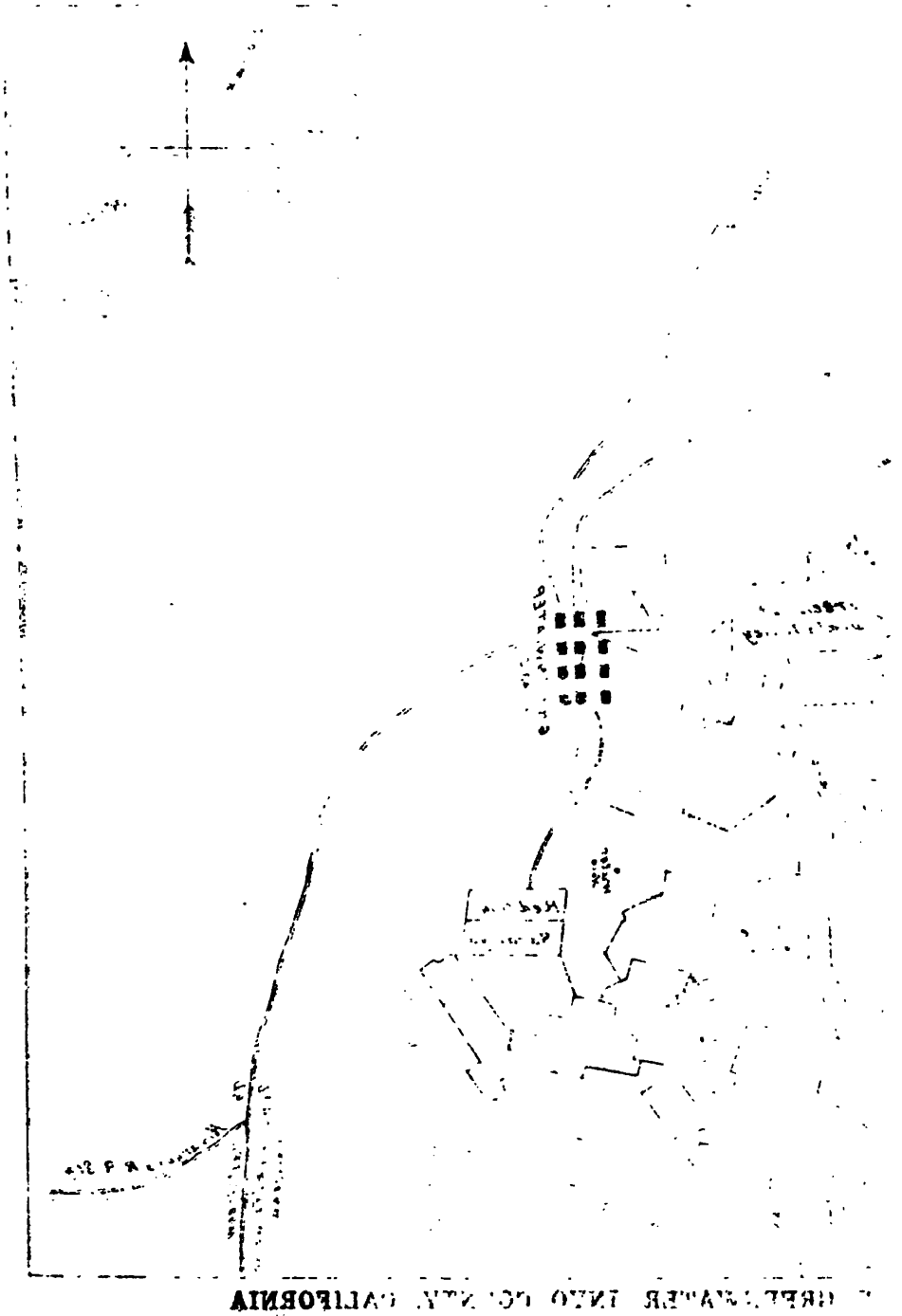
The development consists of a tunnel 72 feet in length following the vein into the mountain, all in carbonate of lead with streaks of galena all through it, also two shafts about 20 feet in depth. The gold values reported increase from $2, 20 feet above the surface, to $12.40 at the surface, and the ore in the face of the tunnel pans free gold.

A fine auto and wagon road has been built from the mine over the mountains to the old Daggett and Furnace Creek road at an expense of $6000. The elevation of this property is 4064 feet.

A fine spring of water has been discovered about a mile and a half easterly from the mine and about 1500 feet above it. This can be carried by gravity to the mine.

There are about twenty claims in this section that are similar to the two described above, and owned by other parties.*

* From company's report.



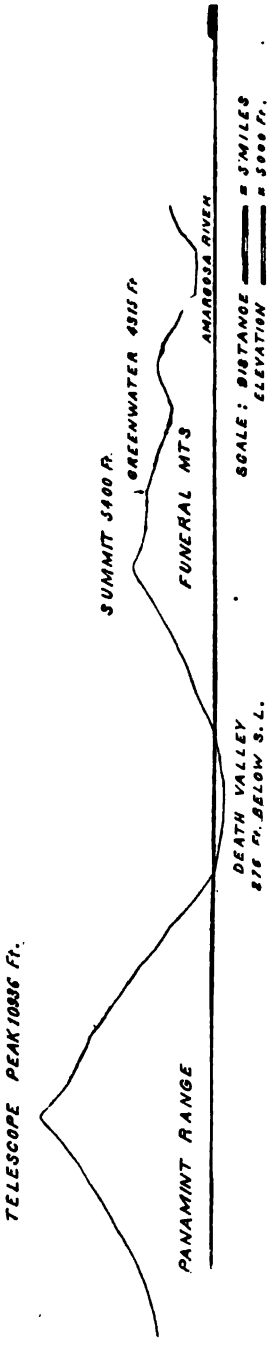
GREENWATER MINING DISTRICT.

This district is situated north of the thirty-sixth degree of latitude, in the western part of the Funeral range, which forms the eastern boundary of Death Valley south of Furnace Creek, and is named Black Mountains on some maps. While the eastern section, with Pyramid Peak as the highest point, consists of sedimentary rocks, whose strata, raised up vertically,

OUTCROP NEAR GREENWATER, DEATH VALLEY, GREENWATER COPPER COMPANY.

gives the mountains a peculiar banded appearance, the western ridge consists entirely of igneous rocks, granite, porphyry, rhyolite, andesite, diorite, etc., with occasional dikes of trap (diabase, basalt, commonly called lava), and one of the highest mountains is formed entirely of this eruptive rock. Sedimentary rocks are only found on the western slope, exposed in the gulches running down to Death Valley.

The eastern and western portions of the Funeral Mountains are separated by a shallow valley running north from Green-



water and ending in the Furnace Creek Canyon, which, turning west, opens into Death Valley. Its total length is twenty-four miles, and the difference in elevation between its termination and its beginning is about 4000 feet. The summit of the western ridge rises 5000 feet above sea level, but some of the peaks attain a greater height, probably 6000 or more, a difference of 1000 to 2000 feet, between the level of the valley, within a distance of about five to six miles, giving a moderate grade to the eastern slope. The bottom of Death Valley on the west sinks to 276 feet below sea level, and there is a drop of 5000 to 6000 feet within ten miles or less, which results in an exceedingly rough country, with sharp ridges, steep slopes, precipices and deep, rugged canyons.

Most of the mines are located on the eastern slope within an area of about twenty miles long by ten miles wide, and the ore is found in dikes of silicious iron, often forming outcrops of considerable width, which traverse the hills in various directions. Within these dikes occur the veins of ore, usually not sharply defined, so that it has become customary to call the entire mineralized dike a vein. The ore bearing dike usually merges imperceptibly into the country rock, but sometimes the walls are distinctly developed, with smooth, polished faces.

The ore, with rare exceptions, consists of oxides of copper, principally malachite, chrysocalla, some azurite, cuprite and melaconite. It is probable that oxidized ores will prevail, to a

great depth, because an artesian bore-hole has shown the water to be below 900 feet.

The existence of copper in Greenwater, which takes its name from a water hole near by, has been known for a long time—it is claimed over fifty years ago, when a party of emigrants perished in Death Valley. But at that time such ore was worthless, and the camp remained comparatively unknown

QUEEN No. 2, GREENWATER DEATH VALLEY COPPER COMPANY, INYO COUNTY.

until February, 1906, when Arthur Kunze, Frank McAllister, and Hank Knight, the pioneers of Greenwater, arrived and took up some claims. At the same time P. Clark sent out some prospectors who located the Furnace Creek property, and sunk the first shaft. In July of the same year Arthur Kunze succeeded in interesting Charles Schwab, L. A. Parkhurst, M. M. McDonald, and Donald Gillies, and from that time dates the later period of active exploration. In January, 1907, the first camp, "Kunze," was moved two miles farther east to

Ramsey and called Greenwater; but four miles northwest from the latter a new camp called Furnace sprung up.

Greenwater, the principal camp and post office, lies almost due east from Telescope Peak in the Panamint range, on the gently inclined eastern slope of the Funeral range, 4315 feet above sea level. It can be reached by stage from Zabriskie, on the Tonopah-Tidewater Railroad, thirty miles south, from

QUEEN No. 3, GREENWATER DEATH VALLEY COPPER MINING COMPANY, GREENWATER, INYO COUNTY.

Amargosa, a station on the Salt Lake-Los Angeles Railroad, fifty miles east; and from Rhyolite by automobile.

In May, 1907, the mines were still in the prospective state; most of the companies did not attempt to take out ore, because it was their intention to prospect at great depth and commence drifting at 500 feet or more. Only one shipment had been made at that time. Thirteen shafts were equipped with gasoline hoists, six of the Greenwater Death Valley Mining and Milling Company; two of the Furnace Creek Company; one of the Furnace Valley Mining Company; one of the Butte Furnace Range Company; one of the Hank Knight Company;

VIEW OF DEATH VALLEY, INYO COUNTY, FROM FUNERAL RANGE.

PANAMINT RANGE AND DEATH VALLEY, FROM SUMMIT OF FUNERAL RANGE, INYO COUNTY.

one of the Red Bay Copper Company; one of the Saratoga Copper Company.

The Greenwater Death Valley Copper Company.—This represents a consolidation of a number of properties with an area of about two hundred claims, or 4000 acres. The offices are located near the old camp Kunze, about two miles from town, and Terry Rourke has charge of the property. Elevation, 4600 to 4800 feet. The six shafts fitted with gasoline hoists are on the following claims:

Glance No. 2, vein of 12 feet; north 65 degrees east; dip 70 degrees south; depth 400 feet.

Queen No. 3, vein of 50 feet; north 45 degrees east; dip 70 degrees south; depth 400 feet.

Queen No. 2, vein of 50 feet; west-east; dip 80 degrees north; depth 500 feet.

Glance No. 5, vein of 100 feet; north 65 degrees east; dip 70 degrees south; depth 250 feet.

Wanda, vein north 25 degrees east; depth 100 feet.

Speculator, vein northwest-southeast; dip northeast; depth 30 feet.

Close to the old town is located the Hank Knight group on an iron outcrop showing some ore.

The Furnace Creek Copper Company's property is located near Furnace Camp. A strong vein runs through the property from southwest-northeast, on which a shaft and incline have been sunk. The latter on the Matte claim, 185 feet deep; the shaft, 550 feet deep, cutting through the vein, is on the Copper Blue, 500 feet distant. The one and only shipment made from Greenwater came from these two workings. It consisted of two lots, reported as assaying 18 per cent and 22 per cent in copper.

Adjoining lies the property of the Furnace Valley Company, with a shaft 250 feet deep on a large vein. The offices of both companies are in Spokane, Washington. I. P. Harvey is the manager.

A little further to the north a deep canyon cuts through the Funeral range into Death Valley, and on the mountain forming its southern slope an immense iron outcrop can be traced for several miles. On the eastern part of this dike is located the property of the Clark Copper Company; on the western

the claims belonging to the Kempland Copper Company. A number of prospect holes sunk all along the dike have exposed ore, and on the Clark property a shaft has been sunk 70 feet on the vein, and a tunnel has been started to crosscut the vein at greater depth.

On the Kempland, a tunnel has been run on the Death Valley side, which, it is claimed, cut a vein 30 feet wide at 280 feet.

GREENWATER.

The offices of both companies are in Los Angeles. I. P. Harvey has charge of the property.

The Butte Furnace Range Company, east of the Furnace Valley claim, has put up a gasoline hoist; the shaft is down 120 feet.

South of Greenwater, about a mile, is the Greenwater Red Boy, showing ore on the surface. The shaft is down 450 feet.

The Saratoga, half a mile farther south, also showed some ore on the surface. The shaft reached 500 feet.

East Greenwater Copper Company, claims located about eight miles from Greenwater in hills east of valley. Incline sunk on large vein. George Badget, manager.

Vindicator Copper Mining Company's property close to the preceding. Good surface showings. Greenwater Brokerage Company.

Calumet and Hecla, on the north side of deep canyon north of Furnace. Reported to have struck good ore in tunnel.

Copper King, about six miles northwest of Furnace on Death Valley slope. Copper outcrop on surface; started tunnel on slope to intercept vein.

Greenwater Black Jack, southwest of town; 80-foot shaft sunk on outcrop. T. D. McDonald, superintendent.

Greenwater Copper Mining Company, Arthur Kunze, president.

Pittsburg Greenwater Copper Company, twenty-five miles south of Greenwater. Good surface showings. C. S. Johnson, secretary, Goldfield, Nevada.

South Greenwater Copper Company, fifteen miles south of Greenwater. Good surface showings. Malcolm Smith, manager.

Willow Creek Camp is situated south of Greenwater, eighteen miles by road, ten by trail; 4380 feet above sea level; at the head of a gulch running into Death Valley.

The Arcturas Copper Company, has sunk a shaft in a lime formation occurring in a porphyritic igneous rock, and carrying oxides and sulphides of copper in irregular bodies. T. L. Oddie, president, Tonopah.

Donaldson & Company, working on a copper outcrop in porphyry, struck a vein carrying galena, and silver, besides copper.

Robicheau & Cox report discovering a vein of sulphides and are prospecting a dike of specular iron.

North of Willow Creek lies a deep and rugged canyon, Sheep Creek, where copper sulphides have been found on the contact between a dolomitic lime foot and a schist hanging wall carrying also oxides with tremolite, lime spar, epidote and pyroxene in the gangue rock.

SAN BERNARDINO COUNTY.

Southeast of the terminus of the Sierra Nevada Mountain range is the vast expanse of the Mojave Desert, a rugged, desolate region, filled with mountain groups and ranges and characterized by a lack of almost every natural condition favorable to the operations of the prospector and miner, but one throughout which nature has lavishly distributed mineral riches in exceptional variety. Copper is one of the minerals thus widely distributed here, but its innumerable occurrences are generally, as far as explored, in quantities too small for commercial exploitation.

The largest portion of the Mojave Desert is included within the bounds of San Bernardino County, which is the largest county in the State. In the southwestern portion is a region unrivaled for beauty of fruits and flowers, fertile and charming valleys, and rich orange groves. Eastward from this Eden, for about 150 miles to the Colorado River, and northward for 75 miles to Inyo County, stretch the forbidding wastes that compose the most of San Bernardino County. It is in the little southwestern corner, where sheltered valleys open to the sea, that the population and developed wealth of the county are mainly concentrated, and it is by this corner that San Bernardino is chiefly known to the world.

The rest of the county is ruled by the miner. Prospectors have persistently explored its desolate and dangerous fastnesses for two generations and brought to general knowledge a mineral empire which capital is slowly possessing. There are few long well-defined belts or lodes, the multitudinous mineral-bearing veins coursing in all directions and being generally and irregularly distributed. There is a number of well-known mining districts scattered through the length and breadth of the county, where concentrations of mineral values have occasional important developments, and in which well-known mines flourish. The metalliferous ores carried by the veins are nearly always base. Gold is the dominant metal produced, but with a more favorable market for silver, the latter

would probably assume first importance. In 1907 the gold output was $158,676 and that of silver $81,339. The county, however, displays a greater variety of mineral products than any other county in the State. In its northern portion are inexhaustible deposits of borax, the chief present mineral product of the county, the output of which in 1907, refined and crude, was valued at about $1,000,000. The only tin mine of the State was operated in this county a few years ago. In this county is an exceptionally large and rich deposit of iron ore awaiting conditions favorable to its exploitation. One of the county's mineral products is turquoise, of which $20,000 worth was mined in 1900. At Colton, Portland cement is made. Among other minerals are lead, salt, soda, antimony, sulphur, asbestos, onyx (aragonite), lime, granite, and marble. There has been much activity in various gold mining districts. The county is crossed by the main line of the Santa Fé Railroad, and branch roads reach different parts of the county. The Southern Pacific road runs through and near the southwestern portion.

While the occurrences of copper ore are frequent and widespread, there are yet but few mines or prospects worthy of particular note, or which attract present attention. But, as with other resources of this great mineral field, there has been but a small beginning made in the prospecting and developing of the copper stored in these rugged wastes, though there is a great number of more or less promising copper claims showing superficial development.

The Copper World.—This is the chief developed and producing mine in the county. It is equipped with a smelting plant. A few years ago considerable high-grade ore was shipped to Swansea from the Tiptop mine in the Lava Beds district, a silver mine in which bunches of rich copper ore were found along fault planes in the country rock. This ore, after concentration by jigging, yielded 33 per cent of copper and 15 ounces of silver per ton. The prevalent copper ores of this region are carbonates and oxides, and characteristically occur in irregularly shaped masses, frequently in association with limestone formations.

Copper World.—This mine is located in Clark Mountain, Clark Mining District, township 16 north, range 13 east, twenty miles from Ivanpah, the terminus of a branch of the Atchison, Topeka, and Santa Fé, leaving the main line at Goff's station. Elevation 5300 feet. It consists of a broad mineralized zone, traversing a low ridge extending from the main mountain about a mile in a southerly direction, lying between lime on the north and porphyry on the south. The

COPPER WORLD MINE, CLARK MINING DISTRICT, SAN BERNARDINO COUNTY.

lime is of a light color near the ore and blue farther away from it. The mineral-bearing zone, over 300 feet wide in places, consists of iron, silica, decomposed portions of the inclosing rocks and veins of copper ore, mostly oxides, malachite largely predominating. South of the porphyry lime is found again and copper has been traced through the entire length of the ridge. On the eastern slope the deposit has been extensively worked on the surface, from the top of the ridge to the bottom of the gulch, a vertical distance of not more than 150 feet. Not

far from the bottom a vertical shaft has been sunk 180 feet on a 5-foot vein of ore, making the greatest depth attained about 300 feet below the outcrop on top of the ridge. Besides the extensive surface workings, which give the slope the appearance of a quarry, there are several tunnels of considerable length and many drifts, stopes, winzes, etc., which combined undoubtedly represent several thousand feet of work.

The property was formerly owned by the Ivanpah Smelting Company, of Los Angeles, which built a smelter at Valley Wells, about five miles southwest of the mine, where the ore was reduced and black copper of about 98 per cent produced in one operation. It is stated that the total value of copper shipped from this plant was about $750,000, but that the cost of smelting and the losses in the slag were too great to make the enterprise profitable, and mine and smelter were shut down and remained idle for some time. Dr. L. D. Godshall in 1907 acquired title to the property and organized the Cocopah Mining Company, which is operating the mine at the present time. D. Murphy, Los Angeles, is president; L. D. Godshall, Needles, general manager of the company.

All the ore from the mine is hauled by teams to Ivanpah and shipped to the smelter at Needles. It averages without being assorted, it is reported, from 6 per cent to 10 per cent copper. Production is limited by the capacity of the smelter, and will be increased. A much larger force of men than employed at present could be used to advantage as soon as the increased output can be handled. There are good accommodations at the mine, but the water has to be hauled a distance of nine miles.

About two miles south, in another low spur of Clark Mountain, is located the Mohawk, showing a strong vein of over 10 feet between a hanging wall of lime and a foot wall of porphyry, strike northwest-southeast; dip almost vertical, slightly inclined northeast. Character of ore the same as in the Copper World, but carrying more azurite. There are several hundred feet of tunnels, drifts, etc., on this vein, and work will undoubtedly be resumed in the future. The property belongs to the Cocopah Company.

On a parallel ridge west of the Copper World, G. Hampstead, of Manvel, has sunk an incline 75 feet on a copper vein from which a reported shipment of 13 per cent ore has been made.

MANVEL, SAN BERNARDINO COUNTY, NEW YORK MOUNTAINS IN THE DISTANCE.

SMELTER AT NEEDLES, SAN BERNARDINO COUNTY.

About seven miles northeast, in township 16 north, range 15 east, is situated the old Ivanpah copper mine, operated by a French company, and shipping some ore.

Located in the same district is the property of the Manvel Mining Company, having a 150-foot shaft on a vein reported as carrying 10 per cent copper. Owners, Victor Marsh and Dr. E. D. King, Pasadena, and S. Norman, of Spokane.

Ivanpah Mammoth, in the Ivanpah Mountains, about five miles from Ivanpah, township 15 north, range 14 east, two veins, one silver and copper, the other copper and gold; shaft down 100 feet.

Copper King, twelve miles from Ivanpah. Both belong to the Quartette Company, of Searchlight.

Standard Mining Company, claims located in same district, have shipped some copper ore.

Leastalk Gold and Copper Company.—Two shafts, each 150 feet in limestone. Ore contains silver, copper, lead, and a little gold.

The Arizona-Mexican Mining and Smelting Company, Needles. This company, practically consisting of the same parties as the Cocopah Company, was organized a few years ago, bought out the Fletcher Smelting Company, and erected a new plant on the site of the old one, less than a mile northwest of Needles, on the bank of the Colorado River. The plant consists of one lead furnace, one copper furnace, one roasting furnace, crusher and sampling floor, assay and general office. The lead furnace is 120 by 42 inches, with six water-jackets, one in front, one in rear, and two on each side, boshed: automatic lead well; eight tuyeres on each side; sheet-iron hood and pipe descending into dust chamber. This type of furnace is known as a 100-ton furnace, although it can attain this capacity only with exceptionally favorable ores. The copper furnace consists of an oval iron water-jacket from the crucible to the feed floor (14 feet above), 96 by 36 inches, with ten tuyeres and iron hood, the same as the lead furnace. Notwithstanding its smaller size, its capacity is greater than that of the lead furnace, owing to the faster smelting of copper ore. The roasting furnace is of the McDougall pattern, a huge iron

cylinder, nearly 30 feet high, with six separate compartments all connected. The fireplace is under the lowest one, but coal has been substituted by oil, and two pipes furnish the necessary fuel. The ore is charged from above, a vertical shaft rotating in the center, furnished with arms to which blades are attached, keeps stirring the pulp and moving it continually from one compartment to the other until it drops out from the last one, being finished. This roaster gives great satisfaction and forms a very essential part of the plant, because the ores treated are mostly sulphides, and most of the iron required for fluxing is obtained by roasting pyrites. Incidentally, a little copper matte is obtained from the lead furnace, but the bulk of the copper ore is smelted by itself in the special furnace, however in a manner different from the process used at the Valley Wells smelter. No attempt is made to obtain metallic copper directly from smelting the oxides, because it has been found that this method entails too great a loss in the slag and that it is more advantageous to save the copper values in form of matte. Sufficient sulphides are therefore added to the oxidized copper ores to produce a high-grade matte, which is shipped east for further treatment. The remarkable success of this smelter, under the management of L. D. Godshall, demonstrates the great advantages Needles offers as a site for reduction works. It is the center of a large mining district, comprising part of Arizona, California, and even Nevada, and containing a great variety of ores carrying the constituents essential for successful smelting.

The New York Mountains are situated about four miles southwest of Manvel, in township 14 north, range 11 east. They consist chiefly of granite and lime, and their highest peaks attain an altitude of about 7000 feet. Several veins have been found on the contact of lime and granite, carrying sulphide of iron, copper, and zinc, in a gangue rock of quartz, lime spar and fluor spar, etc., with gold and silver as principal values, and some lead and copper. G. Hampstead has run several hundred feet of tunnel on a vein of this kind, about five miles from Manvel.

New York Mine.—By far the best known and most important property is the New York mine, located on the southern slope of the mountains. Twenty-five years ago it was owned

by A. E. Blake, of Denver, Colorado, who built the railroad from Goff to Manvel for the purpose of hauling the ore from that mine. Although he had made large shipments of high-grade ore, as it is claimed, the proceeds were not sufficient for the great expense; he was compelled to suspend operations, and finally road and mine passed out of his hands. For many years the mine remained idle, until the property was bought by N. P. and H. T. Sloan, who organized the Sagamore Mining Company, with headquarters in Philadelphia. S. M. Connelly is superintendent at the mine.

The property consists of eight claims, located on both sides of a deep, narrow canyon, the lower workings being at an elevation of 5840 feet. The walls of the canyon consist of phonolite, and all the veins are located in this rock. They are generally well defined and easily traced on both sides of the canyon, rising in many places like walls above the surface. Four veins are known on this property, all, with the exception of one, having a strike southwest by northeast, and an almost vertical dip. The gangue rock is quartz, carrying sulphides or iron, copper, zinc, antimony, and lead, with some oxides of copper, rhodochrosite, and, probably, some arsenides. The first vein encountered from the south runs almost north and south; the ore consists of mixed sulphides, and, perhaps, arsenides, resembling gray copper in appearance, running often high in silver, carrying some copper and a little gold. A 200-foot tunnel cuts the vein, on which a 50-foot shaft has been sunk with a couple of drifts in the bottom.

Vein No. 2, it is stated, carries chloride of silver.

Vein No. 3 can be traced for quite a distance on both sides of the canyon, and on the western side, a little above the bottom of the canyon, a tunnel of 700 feet has been run along its course. Not far from the entrance a shaft has been sunk 100 feet on the vein. Part of the tunnel is run in the foot wall, because the rock is much softer than the quartz, which forms a solid gangue rock between the walls. From time to time the vein has been crosscut, showing its continuation with a width varying from 4 to 12 feet, all of which carries ore that in places forms rich streaks of various thicknesses. A second tunnel of 600 feet, a little distance above, shows exactly the same conditions in regard to size of vein and character of ore.

Vein No. 4, farther north, appears to be very similar to the preceding one.

West of the New York mine, on the other side of the high ridge, is located the property of the Giant Ledge Gold and Silver Company, of Los Angeles. It is stated that the company has completed 700 feet of a tunnel intended to cut an immense ledge 60 feet wide, containing also a fair amount of copper with the other values. An abundance of wood and water and the proximity of the railroad place the mines in the New York Mountains under favorable conditions for exploitation.

Von Trigor Group.—Six claims in the Exchequer mining district, sections 16 and 17, township 11 north, range 18 east, at the eastern side of the county. One of the claims is opened by a tunnel 30 feet long, all in ore. The ore is oxide, said to carry 7.6 per cent copper, $3.96 in gold, and 2½ ounces in silver per ton. The gossan croppings are wide, with east and west strike. The claims are about two miles from the railroad, and the Colorado River is about eighteen miles east of the group. Elevation, 1800 feet. Owner, A. M. Williams, San Francisco.

Copper Mountain Mining Co.—This company, of which W. A. Cooper, of San Bernardino, is president, owns a group of ten claims in the southeastern part of the county, four and a half miles northeast of Victor and four miles east of Oro Grande. The Copper King claim shows gossan croppings 200 feet wide. The ore is sulphide, said to go 8 to 10 per cent copper and some carbonate. The hanging wall of the vein is limestone. The mine is opened by a shaft 200 feet deep on the vein. This mine was first opened twenty-eight years ago, and then closed down, in which condition it remained until recently, when it was reopened and reprospected. Of the other claims, Amazon No. 1 is opened by a shaft 60 feet deep, with a drift to the west 48 feet, and a drift to the north 45 feet. The strike of the vein on all the claims is east, with a northerly dip of about 60 degress. The croppings are limonite. The vein is highly mineralized, with a fair grade of copper-bearing material interspersed. A heavy quartzite dike follows the vein on one side. The ore is reported to assay 10 per cent copper, and a fair amount of gold and silver. The Hekla mine

is opened by three shafts, 30 to 40 feet deep. The Queen is opened by a cut 100 feet long, and from 15 to 25 feet wide, running diagonally across the formation, and exposing three different veins, one of which is 12 feet wide. The ore is sulphide. The other mines of the group show good copper indications. Further extensive developments are under consideration.

Rose Mine.—In Morongo district, 45 miles southeast of Victor; elevation, 7000 feet; strike northwest, with a dip of 30 degrees. The ore carries copper, gold, and silver. The vein is pockety, with walls of limestone. There is a shaft 1000 feet deep, a tunnel 500 feet long, and about 2000 feet of other developments. Reduction works are on the ground. The property is worked as a gold mine primarily. The copper occurs in bunches in the vein and is sorted out and shipped to a smelter in relatively small quantities. The gold ore is reduced in a stamp mill. Owned by R. S. Grant, of Victor.

Camp Vera Group.—Contains thirty claims, all lying in the Morrow mining district, about twenty-five miles north of Barstow, and six miles northeast of Lane's mills; elevation, 3725 feet. A mineralized belt consisting of ironstone rock, running through the county in a northeasterly direction, is partly covered by these claims. The belt varies in width from 50 to 500 feet and can be traced for ten miles. About twenty shafts, 10 to 60 feet deep, have been sunk near the belt. They all show ore containing considerable copper oxide, and other forms of copper mineralization. Open cuts have been made in other places near the belt, showing copper minerals. These shafts and cuts are not on the mineralized belt, but are to the west of it a few hundred yards, and show that the copper deposits have a general dip toward the belt. A sample of six tons of ore was shipped to a smelter and is reported to have given returns of 18 per cent copper and $4 in gold. Ironsides No. 1, of this group, is opened by a shaft 100 feet deep, which follows a streak of highly oxidized mineral, varying from 8 inches to 2 feet in width, which at the bottom of shaft shows an impregnation of copper in the form of a rather unique crystallization. The west wall is well defined, and is of a granitic character. The owner of the Camp Vera group is W. J. Rodgers, of Barstow.

Juanita.—This claim is in the Morrow mining district, twenty-six miles east of Johannesburg. Gossan croppings, varying from 2 to 12 feet in width, appear on this claim, and extend beyond its limits for a distance of over two miles. Beneath them the deposits of ore carrying copper are found to widen out as development proceeds. The hanging walls are granite, and the foot walls limestone. There are three veins about 30 feet apart covered by this claim. One shaft is 212 feet deep, two are 60 feet, and one is 40 feet deep. At 190 feet on the 212-foot shaft a crosscut has been run, but it does not reach either wall. The ore is said to go 17 per cent in copper and $3 in gold. The vein matter is of a talcose nature carrying copper sulphides throughout. Owner, Union Development Company, of Boston.

Juanita Group.—Besides the Juanita mine, there are 141 other claims, constituting what is called the Juanita group. Among these claims, those having the most notable development are the Henrietta, Lookout, and Big Three. The Henrietta is opened by a shaft 52 feet deep, drift 28 feet long, and a winze from its end 10 feet deep. The character of the ore is oxide. The width is undetermined. The ore is said to assay 14 per cent copper, $12 in gold, and 2 ounces of silver to the ton. The Lookout claim is opened by a tunnel 30 feet long, striking a vein of carbonate ore about 3 feet in width, said to contain 32 per cent copper with no gold or silver. The foot wall is porphyry, with intrusions of limestone. There are eighty-six other shafts on the group, attaining depths of from 20 to 30 feet, showing veins of oxide ores from 2 to 40 feet in width, said to average 7 per cent copper, $4 in gold, and 3 ounces of silver. The Big Three claim is opened by a shaft 77 feet deep.

Lytle Creek Mine.—It lies twenty miles northwest of San Bernardino, and has been worked for twenty years. It contains bunches of high-grade copper ore.

The Peacock, or Lava Beds, Mining District.—One hundred miles east of San Bernardino, in the south-central part of the county. It contains some claims with gossan croppings undedeveloped that show indications of copper ores.

Ord Copper Group.—This group consists of twenty-three claims in Ord Mountain, fourteen miles south of Daggett. The strikes are nearly north and east. The deposits carry copper and gold, the former largely predominating, except in a few places. The main vein is about three miles long and averages about 20 feet wide. The hanging wall is granite and the foot wall decomposed porphyry. The ore is copper carbonate and sulphide. A shaft 154 feet deep and a tunnel 400 feet long, with about 1000 feet of other development work, constitute the openings. Several of the claims are patented. Osborne & Drew, of Daggett, owners.

About forty miles northeast of Whitewater station, on the Southern Pacific Railroad, in Riverside County, is a group of claims located in the Copper Mountains, a small group off the San Bernardino range, just west of the Twenty-nine Palms district. Owner, H. R. Hudspeth, of Los Angeles. The claims are on a lode crossing the principal lodes of the county. The deposit is between lime and porphyry. The copper is in the form of cuprite and chrysocolla. On the outcrop the mineralized zone is about 250 feet wide. The development consists of shafts, drifts, and cuts, and a tunnel 105 feet long.

About three miles north of Klinefelter station is a mine owned by Lewis & Shafer, displaying a vein from 3 to 6 feet wide, between massive slate and granite and porphyry walls. The ore is stated to bear 20 per cent of copper associated with gold. A shaft has been sunk to a depth of 75 feet and a tunnel driven 50 feet, with about 100 feet of other development work.

Leastock Gold and Copper Mining Company.—A group of twelve claims in the Vanderbilt district, San Bernardino County. Vein between lime and granite, carrying ore reported at 7 per cent to 30 per cent copper, averaging 12 per cent. Shaft 150 feet; total development about 500 feet. (Reported by the Leastock Gold and Copper Mining Company.)

In the southeast corner of San Bernardino County are the Whipple and Monument Mountains and west of these the Turtle Mountains, where some old mines are located, which produced rich ore in former years, when the Planet and Rawhide mines in Arizona were in operation. After lying idle a long time, this part of the county again attracted attention, work on some of the old mines was resumed, and a number

of new prospects were developed. The following information about this region was obtained from Mr. S. A. McDonald, of Los Angeles, and Mr. P. Walters, of Santa Monica:

American Eagle Group.—Situated about thirty-five miles south of Needles; has a shaft 130 feet, with some drifts showing sulphide ores.

Adjoining on the north is the Dayton group, and the Wilbur and Copperfield group, which has a gasoline hoist.

Still farther south are the Wyatt Earp, Martin, Bonner group, and several other claims.

Fifteen miles southwest in the Turtle Mountains lies the Horn group of fifteen claims, with 700 feet of development work, showing some high-grade copper ore.

In the Arica Mountains, twelve miles farther south, are located the Grey and Brown groups, on which considerable work has been done, showing bodies of copper-gold ore.

Large gossan outcrops and copper ore have been found in Ironwood district, some distance south of these properties.

Sixty miles south of Needles, occupying the extreme southeast corner of San Bernardino County, are the Whipple and Monument range, and a little west of these the Turtle Mountains, where some rich gold-copper ore was taken out forty years ago, at the time when the Rawhide and Planet mines in Arizona were producing. After being abandoned and lying idle for a long time this district again attracted attention, and several mining camps have been established.

Copper Basin is situated in Mount Whipple district, not far from the Colorado River, and several veins have been located on a contact between a foot wall of diorite and a hanging wall of lime. A. Wilson and A. M. Cornelius, of Needles, own four claims on a 7-foot vein; R. K. Neil, of Spokane, owns a group of twelve claims, with a 20-foot vein of oxidized ores; on the Catspaw are two shafts of 100 feet.

The D. & W. (Dayton & Wilbur) has a shaft and hoist; the American Eagle group in Monument district has a shaft of 130 feet, exposing a large body of sulphides, which are encountered at a little depth in this region, the water line being only 75 to 100 feet. On the eastern slope of Turtle Mountain lies the Black Metal mine, and in the northern part of this range, the Sunrise district has been recently located.

Twenty miles farther down the river, in Riverside County, eighty-one miles from Needles, P. Walters, of Santa Monica, discovered ore and located a number of claims. The formation is granite, schist, and lime; course of veins southeast-northwest; ore, copper, with a little gold. One shaft is down 150 feet and one tunnel on Copper Hill is 35 feet in ore. Several shipments of 20 per cent ore, mostly oxides, have been made to the smelter in El Paso, it is reported. Sulphides are expected at 200 feet, the water level.

Between Goff station and Manvel lies the Von Trigger camp, where a number of claims have been located on gold-bearing quartz. Some of the veins carry copper, particularly in the group of claims owned by A. H. Cramer, Blake post office.

Old Dad Mountain Mining District.—This district, situated northeast of Bagdad, was discovered by a Piute Indian, named Hikorum, in 1897, who brought some ore to Needles and described the locality where he had found it, whereupon some miners went to the place and made the first locations. The principal formation is granite, but the veins are found in a porphyritic rock, varying from coarse-grained rock resembling granite, to a fine-grained variety, apparently a quartz-porphyry. The walls of the veins are generally not clearly defined, which applies especially to the foot wall, and it is, therefore, difficult to determine accurately the width. The principal vein is from 4 to over 20 feet wide; strike 20 degrees west, north 20 degrees east; dip 60 to 72 degrees. Carries quartz, iron, lime, etc., and values in gold and copper, mostly oxides with some glance, and a little silver. This vein has been traced for more than two miles and on it is located the property of the two principal mining companies in the district.

The Orange Blossom Mining and Milling Company own ten claims, three of which are located along the apex of the vein, which has been traced through their entire length. This property is situated in township 8 north, range 11 east, nine miles from the station Bagdad, 2690 feet above sea level, or 1975 feet above that place, which is 715 feet above sea level. Besides the shallow openings along the apex of the vein, by which its course has been traced, the principal workings are on the Orange Blossom claim and consist in two shafts not far

apart, following the vein at an angle of 72 degrees, the dip being west by north. The old shaft lies farther north, is 106 feet deep, and has one drift running north 40 feet, at 15 feet, and another at 55 feet running south, showing ore in their entire length. The new shaft is 365 feet deep, well timbered, of double compartment, one for bucket, one for ladder way, and is equipped with a 15-horsepower gasoline hoist. At the 55-foot

ORANGE BLOSSOM MINE, DAD MOUNTAIN DISTRICT, SAN BERNARDINO COUNTY.

level are 106 feet of drifts, connecting with the old shaft; at the 100-foot level there are 35 feet of drifts; at the 200-foot level, 45 feet; at the 300-foot level, 35 feet, all showing a wide vein, and ore. Between the two shafts is an open cut 60 feet long and about 8 feet deep, all in vein with several feet of good ore. Altogether there are 471 feet of shaft, 261 feet of drifts, and 60 feet of cut, or 791 feet of development. The camp has good accommodations and an assay office. Office: San Diego; John Denair, president; W. I. Coapman, secretary.

The Orange Blossom Extension adjoins the preceding on the north. Its property consists of twenty claims, five of which are located on the same vein which continues without any particular change in its geological and mineralogical features. Its main workings are located on the Bengal claim, and consist of a 110-foot shaft, connected in the bottom with a 125-foot tunnel, 210-foot crosscuts, drifts, and shafts, or nearly 450 feet of development altogether. It has been reported that since this property was examined a large flow of water has been struck in the Bengal shaft at a depth of 715 feet. Office, San Diego; president, J. A. Hodgman; secretary, Wm. H. Holcomb.

Two miles northwest of this camp a vein was discovered by C. T. Seburn, upon which was located the claim known as the Lady Lou, which carries high values in copper and gold, the latter being frequently visible in the ore. Course northeast by southwest; dip northwest. Tunnel 65 feet with 18 feet winze on 4-foot vein. Two other veins have been discovered on this property which show well in copper on the surface.

RIVERSIDE COUNTY.

Riverside County comprises a wide strip of territory stretching across the desert region of the southeastern part of the State from the boundary at the Colorado River westward to a terminus on the Pacific Slope. In this county is the San Bernardino range, which separates the Mojave and Colorado deserts, and the county thus includes portions of both theses arid wastes. The western portion has become, with irrigation, one of the chief garden spots of Southern California, and the orange groves and floral wealth of this region have spread afar the fame of Riverside's glory.

Topographically, geologically, and mineralogically the desert region of Riverside resembles that of San Bernardino County to its north. Mineral wealth is similarly distributed, though the mining industry is of smaller relative importance. There has been much recent activity in the prospecting and develop-

ment of the several districts, chiefly in respect to gold. Among the varied minerals which are widely distributed over the county and which will be the basis of a great future mineral industry are silver, coal, salt, pottery clay, asbestos, marble, granite, etc. Copper is of wide occurrence in association with gold and silver ores, and a number of properties have received superficial development, but none have yet assumed importance as producers. The Southern Pacific Railroad crosses the county diagonally, giving fairly convenient access to several mineral districts. The southern boundary of the county runs through the depression known as Salton Lake, the lowest part of which is 275 feet below the level of the sea.

Orphan Boy Mines.—They are in the Palen Mountains, about two miles south of Packard's Well, Ironwood district. Elevation, 1850 feet. There are three claims in this group. The minerals are copper, gold, and silver, and the mineralized zone is about 100 feet wide, dipping southwardly. The country rock is porphyry. There are three open cuts and a shaft 8 feet deep revealing good ore. Assays are reported to show more than 30 per cent copper. The hanging wall is limestone or granular gypsum, dipping about 50 degrees. There is considerable massive epidote on these claims. Owner, P. W. McGrath, Los Angeles.

Palen Copper Mines.—Located on the west side of Palen Mountains, about ten miles east of Palen Wells. The character or the ore is copper, gold, and silver. The vein matter is about 50 feet wide. The country rock is quartzite and porphyry. Five shallow shafts have been excavated, which show good ore averaging about 30 per cent copper. There are two claims—The Copper-Silver Glance and The Ophir. The former is located on a spur of Palen Mountain in a canyon coming in from the east. It is about 250 feet above the creek bed and 2100 feet above sea level. There are eight cuts and prospect holes in this spur, all yielding copper. The ledge lies suitable for quarrying. Sandstone, quartzite, and granulite are the country rock. Owner, H. G. Adams, Los Angeles.

Homestake Group.—There are five claims in this group, located on the east side of Palen Mountains, about eight miles

northwest of McCoy Springs, at an elevation of 1600 to 2350 feet, and but three or four miles from the Orphan Boy and Ophir mines on the opposite side of the mountains. The five claims are on the same ledge, and carry copper, gold, and silver. The width of the ledge matter is 20 to 50 feet, and it yields copper-silver glance, azurite, and malachite. The development work consists of two shallow shafts and three open cuts. Owners, Adams & Creasinger, Los Angeles.

Mountain King Group.—Consists of three claims located on the east side of McCoy Mountains. The strike is northwest and southeast, and the dip northeast. The ore, which is azurite and malachite, contains copper, gold, and silver. The deposit is in ledge form, the vein matter being about 30 feet wide. A shaft 40 feet deep has been sunk, and four open cuts have been made, all revealing good ore. The country rock is porphyry and quartzite. The mine is easily accessible. Elevation, 1800 feet. Owners, Adams & Creasinger, Los Angeles.

Randolph & Hamilton Claims.—Consist of two groups and seven claims in Santa Maria Mountains. The deposits consist of copper and chromic iron, and some gold, at an elevation of about 1750 feet. A shaft 21 feet deep has been sunk and four or five cuts made. The copper value is about 7 or 8 per cent. Iron largely predominates. There is much limestone as country rock, and some porphyry. Owners, Randolph & Hamilton, Ehrenberg, Arizona.

Anderson Claims.—There are twenty-six claims in this group, located in the northern part of the county. The strike is northwest. The ore carries copper with a little silver, and the veins vary from 2 to 6 feet in width. The hanging wall is granite. A shaft 80 feet deep has been sunk and a tunnel 100 feet long driven, with considerable other development work in shafts, etc. Six men were employed. Anderson & Co., owners.

"Badger State" Group.—Ten claims located in the McCoy Mountains, about twenty miles west of the Colorado River. The ore contains copper, gold, and silver. There are a vast number of stringers from 6 inches to 4 feet wide. The walls are porphyry and limestone, granite being the country rock. There is also much iron in these claims. About 300 feet of

development work has been done in open cuts, shallow shafts, etc., which reveal good ore. The present owner is S. P. Creasinger, of Los Angeles.

Fluor Spar Group.—This group of three claims is in the Palen Mountains, one mile southwest of Packard's Well, Ironwood district. The ledge matter is about 100 feet wide, and strikes northeast and southwest. The ore contains copper, gold, and silver. The country rock is largely porphyry and limestone. The copper represents azurite, malachite, etc., and some red oxide. There are two open cuts penetrating the mountains 20 feet or more. Elevation, 1800 feet. The group is owned by Jacob Berge. The mine contains much fluor spar, Iceland spar, and limpid quartz. The ore lies suitable for quarrying.

The Ironwood or McCoy Mountain district contains a highly mineralized zone of copper, silver, gold, and lead ores. High-grade sulphide deposits are known to exist, principally in the form of kidneys. Besides these, native copper is occasionally met with. The district is twenty-two miles from the Colorado River, and ore has been shipped by that route to reduction works.

In the Shadow Mountain district there are localities showing gold, copper, and lead ores. The copper ores are malachite and oxides.

Vulture Crag.—The property is in the western part of the county, fourteen miles east of Capistrano, in Trabucco Canyon. There is not sufficient development to determine the extent of the deposit. In an 8-foot tunnel a ledge over 4 feet in width has been exposed. The ore is chiefly chalcopyrite, and the croppings may be traced for several miles. A. B. Joplin, of Santa Ana, owner.

Copper ore was discovered eighty miles south of Needles eight years ago by P. Walters, who located a number of claims. The formation is granite, schist and lime; course of vein southeast; ore carries copper and a little gold. One shaft is down 150 feet and one tunnel in Copper Hill shows 35 feet of copper ore. It is reported that several shipments of 20 per cent copper, mostly oxides, were made to the smelter in El Paso.

SAN DIEGO COUNTY.

San Diego County stretches from the Pacific shore to Imperial County. The lower western slope, near the sea, is a populous, rich, and fertile region, famed for its climate, scenery, and productions. Back from the shore, mountains mark the eastern limit of fertility and beauty and the western limit of the expanse of arid mountain and valley composing the Colorado Desert and much the larger portion of the county's big area. In the mountains near the coast are various minerals, such as characterize the upper part of Lower California, and mineral wealth is widely distributed throughout the county eastward. Rugged and desolate mountains fill most of the desert area, and among them the persistent prospector and the enterprising mining capitalist have established several important mining districts and developed some of the leading gold mines of the State. Copper minerals occur in association with the ores of other metals quite extensively throughout the county, but no copper deposits worthy of note as such have been developed in the desert region. The two prospects noted below are near the coast and are not to be associated with those of the arid region farther east.

Danes Lea Mining Co.—The mines of this company are located near the coast, eight miles east of Encinitas, in township 13 south, range 3 west, San Bernardino meridian. The development consists of two shafts 200 feet apart and a tunnel. One of the shafts is down 280 feet and the other 100 feet. The shafts are sunk in the ore body, the ledge being about 3 feet wide in porphyry formation. The ore is chalcopyrite, averaging a fair percentage of copper. A 12-horsepower gasoline hoist has been installed. The company intend to erect a concentration plant as soon as the developments will justify the expenditure and to ship the concentrates to a smelter. In the group there are twenty claims, all showing copper in the croppings. W. H. Mackinnon of Encinitas is manager, and W. C. Harland, of San Diego, president.

Barona Copper Claims.—This property is located thirty-five miles northeast of San Diego and twelve miles northeast of Lakeside, in township 14 south, range 1 east, San Bernardino meridian. The nearest point on the Cuyamaca Railroad is six miles distant. The development consists of two 25-foot shafts and two 25-foot crosscuts in the ore body. The ledge, about 20 feet wide, is mineralized throughout, and copper croppings are exposed for about 150 feet in length on its strike and where developments have been performed. The ore is principally chalcopyrite and black oxide of copper. It assays about 8 per cent copper and carries $1.50 in gold and 8 ounces of silver per ton. The ledge, a schistose quartz, is in granite. T. J. Daley, of San Diego, owner.

LOS ANGELES COUNTY.

Los Angeles County, which reaches eastward from the sea in the most favored portion of southern California, is far-famed for its climate and the wealth and beauty of its orange groves and luxuriant gardens, and possesses, in the city of Los Angeles, the metropolis of this large section of the State. There are three rich oil fields in the county, those of the city of Los Angeles, Whittier, and Puente. The petroleum output in 1907 was 4,318,739 barrels, and oil refineries produced a large amount of asphaltum.

North and east of the fertile valley regions of the county, in its northern and eastern parts, is a considerable portion of the Mojave Desert, similar in character to the desert regions of the adjoining counties of Kern, San Bernardino, and Riverside. In this region placer gold was mined before Marshall made his discovery in 1848, and ever since then placer mining operations have continued on a small scale. A few valuable quartz mines have been developed. Copper was noted and a little ore mined near Soledad Pass before the American occupation. The copper deposits are in the northeastern part of the county, near and northeast of Acton, in Soledad Pass, on the edge of the Mojave Desert.

Palm Development Co.—This company has superficially developed some claims located twenty-three miles northeast of Acton and three miles southeast of Little Rock Creek, in section 30, township 5 north, range 10 west, San Bernardino meridian. The ore is found in deposits in a porphyritic dike, which averages 180 feet in width. The mineralized zone may be traced for one and a half miles. Three shafts have been sunk. While some ore was encountered in these shafts, they failed to show any defined ledge or continuous deposit. The ore is chiefly malachite and carries gold and silver. The mines have been leased to Messrs. Elliot & Leavitt, who erected a leaching plant. E. M. Ross and Joseph H. Call, of Los Angeles, owners.

An extension of the claims of the Palm Development Company is owned by William M. Van Dyke, of Los Angeles.

Free Cuba.—Located a half mile south of the Southern Pacific Railroad station at Acton. This mine was first worked about forty-five years ago, and abandoned. The old shaft has been cleaned out, and at the bottom, 200 feet from the surface, samples of native copper were found. A quartz ledge in granite is 23 feet wide. Ira L. Houser, of Acton, owner.

Mooney & Williams Claim.—Located two miles south of Acton. A crew was developing the property, and in the tunnel some fair copper ore had been encountered. The character of the ledge is similar to that of the Free Cuba. Mooney & Williams, of Acton, owners.

APPENDIX.

CALIFORNIA STATE MINING BUREAU.

This institution aims to be the chief source of reliable information about the mineral resources and mining industries of California.

It is encouraged in its work by the fact that its publications have been in such demand that large editions are soon exhausted. In fact, copies of them now command high prices in the market.

The publications, as soon as issued, find their way to the scientific, public, and private libraries of all countries.

STATE MINERALOGIST.

The California State Mining Bureau is under the supervision of Hon. Lewis E. Aubury, State Mineralogist. It is supported by legislative appropriations, and in some degree performs work similar to that of the geological surveys of other states; but its purposes and functions are mainly practical, the scientific work being clearly subordinate to the economic phases of the mineral field, as shown by the organic law governing the Bureau, which is as follows:

SEC. 4. It shall be the duty of the State Mineralogist to make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State. It shall be his duty: To collect statistics concerning the occurrence of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use; to make a collection of typical geological and mineralogical specimens, especially those of economic or commercial importance, such collection constituting the Museum of the State Mining Bureau; to provide a library of books, reports, drawings, bearing upon the mineral industries, the sciences of mineralogy and geology, and the arts of mining and metallurgy, such library constituting the Library of the State Mining Bureau; to make a collection of models, drawings, and descriptions of the mechanical appliances used in mining and metallurgical processes; to preserve and so maintain such collections and library as to make them available for reference and examination, and open to public inspection at reasonable

FERRY BUILDING, SAN FRANCISCO, ONE HALF THE UPPER FLOOR OF WHICH IS OCCUPIED BY THE STATE MINING BUREAU.

hours; to maintain, in effect, a bureau of information concerning the mineral industries of this State, to consist of such collections and library, and to arrange, classify, catalogue, and index the data therein contained, in a manner to make the information available to those desiring it, and to provide a custodian specially qualified to promote this purpose; to make a biennial report to the Board of Trustees of the Mining Bureau, setting forth the important results of his work, and to issue from time to time such bulletins as he may deem advisable concerning the statistics and technology of the mineral industries of this State.

THE BULLETINS.

The field covered by the books issued under this title is shown in the list of publications. Each bulletin deals with only one phase of mining. Many of them are elaborately illustrated with engravings and maps. Only a nominal price is asked, in order that those who need them most may obtain a copy.

THE REGISTERS OF MINES.

The Registers of Mines forms practically both a State and a County directory of the mines of California, each county being represented in a separate pamphlet. Those who wish to learn the essential facts about any particular mine are referred to them. The facts and figures are given in tabular form, and are accompanied by a topographical map of the county on a large scale, showing location of each mineral deposit, towns, railroads, roads, power lines, ditches, etc.

HOME OF THE BUREAU.

The Mining Bureau occupies the north half of the third floor of the Ferry Building, in San Francisco. All visitors and residents are invited to inspect the Museum, Library, and other rooms of the Bureau and gain a personal knowledge of its operations.

THE MUSEUM.

The Museum now contains over 16,000 specimens, carefully labeled and attractively arranged in show cases in a great, well-lighted hall, where they can be easily studied. The collection of ores from California mines is of course very extensive, and is supplemented by many cases of characteristic ores from the principal mining districts of the world. The educational

value of the exhibit is constantly increased by substituting the best specimens obtainable for those of less value.

These mineral collections are not only interesting, beautiful, and in every way attractive to the sightseers of all classes, but are also educational. They show to manufacturers, miners, capitalists, and others the character and quality of the economic minerals of the State, and where they are found. Plans have been formulated to extend the usefulness of the exhibit by special collections, such as one showing the chemical composition of minerals; another showing the mineralogical composition of the sedimentary, metamorphic, and igneous rocks of the State; the petroleum-bearing formations, ore bodies, and their country rocks, etc.

Besides the mineral specimens, there are many models, maps, photographs, and diagrams illustrating the modern practice of mining, milling, and concentrating, and the technology of the mineral industries. An educational series of specimens for high schools has been inaugurated, and new plans are being formulated that will make the Museum even more useful in the future than in the past. Its popularity is shown by the fact that over one hundred thousand visitors registered yearly, while many failed to leave any record of their visit.

THE LIBRARY.

This is the mining reference library of the State, constantly consulted by mining men, and contains between 4000 and 5000 volumes of selected works, in addition to the numerous publications of the Bureau itself. On its shelves will be found reports on geology, mineralogy, mining, etc., published by states, governments, and individuals; the reports of scientific societies at home and abroad; encyclopædias, scientific papers, and magazines; mining publications; and the current literature on mining ever needed in a reference library. Manufacturers' catalogues of mining and milling machinery by California firms are kept on file. The Registers of Mines form an up-to-date directory for investor and manufacturer.

The librarian's desk is the general bureau of information, where visitors from all parts of the world are ever seeking information about all parts of California.

MINERAL MUSEUM, CALIFORNIA STATE MINING BUREAU.

READING-ROOM.

This is a part of the Library Department and is supplied with over one hundred current publications. Visitors will find here various California papers and leading mining journals from all over the world.

The Library and Reading-room are open to the public from 9 A. M. to 5 P. M. daily, except Sundays and holidays, and from 9 A. M. to 12 M. on Saturdays.

THE LABORATORY.

This department identifies for the prospector the minerals which he finds, and tells him the nature of the wall rocks or dikes that he may encounter in his workings; but this department *does not* do assaying nor compete with private assayers. The presence of minerals is determined, but not the percentage present. No charges for this service are made to any resident of the State. Many of the inquiries made of this department have brought capital to the development of new districts. Many technical questions have been asked and answered as to the best chemical and mechanical processes of handling ores and raw material. The laboratory is well equipped.

THE DRAUGHTING-ROOM.

In this room are prepared scores of maps, from the small ones filling only a part of a page, to the largest County and State maps; and the numerous illustrations, other than photographs, that are constantly being required for the Bulletins and Registers of Mines. In this room, also, will be found a very complete collection of maps of all kinds relating to the industries of the State, and one of the important duties of the department is to make such additions and corrections as will keep the maps up to date. The seeker after information inquires here if he wishes to know about the geology or topography of any district; about the locations of the new camps, or positions of old or abandoned ones; about railroads, stage roads, and trails; or about the working drawings of anything connected with mining.

MINERAL STATISTICS.

One of the features of this institution is its mineral statistics. Their annual compilation by the State Mining Bureau began in 1893. No other State in the Union attempts so elaborate a record, expends so much labor and money on its compilation, or secures so accurate a one.

The State Mining Bureau keeps a careful, up-to-date, and reliable but confidential register of every producing mine, mine-owner, and mineral industry in the State. From them are secured, under pledge of secrecy, reports of output, etc., and all other available sources of information are used in checking, verifying, and supplementing the information so gained. This information is published in an annual tabulated, statistical, single-sheet bulletin, showing the mineral production by both substances and counties.

TOTAL GOLD PRODUCT OF CALIFORNIA—1848-1907.

1848	$245,301	1879	$19,626,654
1849	10,151,360	1880	20,030,761
1850	41,273,106	1881	19,223,155
1851	75,938,232	1882	17,146,416
1852	**81,294,700**	1883	24,316,873
1853	67,613,487	1884	13,600,000
1854	69,433,931	1885	12,661,044
1855	55,485,395	1886	14,716,506
1856	57,509,411	1887	13,588,614
1857	43,628,172	1888	12,750,000
1858	46,591,140	1889	11,212,913
1859	45,846,599	1890	12,309,793
1860	44,095,163	1891	12,728,869
1861	41,884,995	1892	12,571,900
1862	38,854,668	1893	12,422,811
1863	23,501,736	1894	13,923,281
1864	24,071,423	1895	15,334,317
1865	17,930,858	1896	17,181,562
1866	17,123,867	1897	15,871,401
1867	18,265,452	1898	15,906,478
1868	17,555,867	1899	15,336,031
1869	18,229,044	1900	15,863,355
1870	17,458,133	1901	16,989,044
1871	17,477,885	1902	16,910,320
1872	15,482,194	1903	16,471,264
1873	15,019,210	1904	19,109,600
1874	17,264,836	1905	19,197,043
1875	16,876,009	1906	18,732,452
1876	15,610,723	1907	16,727,928
1877	16,501,268		
1878	18,839,141	Total	$1,469,513,691

TOTAL MINERAL PRODUCT OF CALIFORNIA FOR 1907.

The following table shows the yield and value of mineral substances of California for 1907, as per returns received at the State Mining Bureau, San Francisco, in answer to inquiries sent to producers:

	Quantity.		Value.
Asbestos	70	tons	$3,500
Asphalt	79,718	tons	1,058,400
Bituminous rock	24,122	tons	72,835
Borax	106,825,000	lbs.	1,200,913
Cement	1,613,563	bbls.	2,585,577
Chrome	302	tons	6,040
Clay (brick)	362,167	M	3,438,951
Clay (pottery)	160,385	tons	254,454
Coal	23,734	tons	55,849
Copper	32,602,945	lbs.	6,341,387
Fuller's earth	100	tons	1,000
Gems	.....		232,642
Gold	809,213.52	ounces	16,727,928
Granite	399,431	cu. ft.	373,376
Gypsum	8,900	tons	57,700
Infusorial earth	2,531	tons	28,948
Iron ore	400	tons	400
Lead	164	tons	16,690
Lime	684,218	bbls.	756,376
Limestone	230,985	tons	406,041
Macadam	1,544,617	tons	1,082,302
Magnesite	6,405	tons	57,720
Manganese	1	ton	25
Marble	37,512	cu. ft.	118,066
Mineral paint	250	tons	1,720
Mineral water	2,924,269	gals.	544,016
Natural gas	169,991	cu. ft.	114,759
Paving blocks	4,604	M	199,347
Petroleum	40,311,171	bbls.	16,783,943
Platinum	300.07	ounces	6,255
Pyrites	82,270	tons	251,774
Quartz crystals	4,000	lbs.	10,000
Quicksilver	17,379	flasks	663,178
Rubble	744,271	tons	832,713
Salt	88,063	tons	310,967
Sand-glass	11,065	tons	8,178
Sandstone	159,573	cu. ft.	148,148
Serpentine	1,000	cu. ft.	3,000
Silver	1,138,858	ounces	751,646
Slate	7,000	squares	60,000
Tungsten	.....		120,587
Zinc	.....		10,598
Total			$55,697,949

MINING BUREAU PUBLICATIONS.

Publications of this Bureau will be sent on receipt of the requisite amount and postage. **Only stamps, coin or money orders will be accepted in payment. Do not send personal checks.**

Address all communications regarding publications to **LIBRARIAN.**

(All publications not mentioned are exhausted.)

SALE OF MINING BUREAU PUBLICATIONS.

Under Section 8, amendment to the Mining Bureau Act, approved March 10, 1903, your attention is respectfully called to that portion of the amendment which states:

"The board (board of trustees) is hereby empowered to fix a price upon, and to dispose of to the public, at such prices, any and all publications of the Bureau, including reports, bulletins, maps, registers, etc. The sum derived from such disposition must be accounted for and used as a revolving printing and publishing fund for other reports, maps, registers, etc. The prices fixed must approximate the actual cost of printing and issuing the respective reports, bulletins, maps, registers, etc., without reference to the cost of obtaining and preparing the information embraced therein."

	Price.	Postage.
Report XI—1892, First Biennial	$1.00	$0.15
Report XIII—1896, Third Biennial	1.00	.20
Bulletin No. 6—"Gold Mill Practices in California" (3d ed.)	.50	.04
Bulletin No. 9—"Mine Drainage, Pumps, Etc.," bound	.60	.08
Bulletin No. 15—Map of Oil City Oil Fields, Fresno County, California"	.05	.02
Bulletin No. 23—"Copper Resources of California"	.50	.12
Bulletin No. 24—"Saline Deposits of California"	.50	.10
Bulletin No. 27—"Quicksilver Resources of California"	.75	.08
Bulletin No. 30—"Bibliography Relating to the Geology, Palæontology and Mineral Resources of California," including List of Maps	.50	.10
Bulletin No. 31—"Chemical Analysis of California Petroleum"	...	.02
Bulletin No. 32—"Production and Use of California Petroleum"	.75	.08
Bulletin No. 36—"Gold Dredging in California" (3d ed.)	.50	.08
Bulletin No. 37—"Gems and Jewelers' Materials of California" (2d ed.)	.50	.08

	Price.	Postage.
Bulletin No. 38—"Structural and Industrial Materials of California"	$0.75	$0.20
Bulletin No. 42—"Mineral Production of California"—1905	...	.02
Bulletin No. 45—"Auriferous Black Sands of California"	.10	.02
Bulletin No. 46—"Index of Mining Bureau Publications"	.30	.06
Bulletin No. 47—"Mineral Production of California"—1906	...	.02
Bulletin No. 48—"Mineral Production of California for 20 Years"	...	.02
Bulletin No. 50—"Copper Resources of California"	...	...
Bulletin No. 51—"Mineral Production of California"—1907	...	.02
Bulletin No. 52—"Mineral Production of California for 21 Years"	...	.02
California Mine Bell Signals (Cardboard)	.05	.02
California Mine Bell Signals (Paper)	.03	.02
Gold Production in California from 1848 to 1907	...	.02
Register of Mines, with Map, Amador County	.25	.08
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Map of Mother Lode	.05	.02
Map of Desert Region of California	.10	.02
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Map of Forest Reserves in California (Mounted)	.50	.08
Map of Forest Reserves in California (Unmounted)	.30	.06
Map of Minaret Mining District, Madera County	.20	.02

Samples (limited to three at one time) of any mineral found in the State may be sent to the Bureau for identification, and the same will be classified free of charge. **No samples will be**

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determined if received from points outside the State. It must be understood, that **no assays, or quantitative determinations will be made.** Samples should be in a lump form if possible, and **marked plainly with name of sender outside of package, post office address, etc. No samples will be received unless charges are prepaid. A letter** should accompany sample and a **stamp** should be enclosed for reply.

Address all samples and communications regarding samples to **LABORATORY.**

LAW RELATING TO MISREPRESENTATIONS OF MINES BY ANY OFFICER OF A CORPORATION TRANSACTING BUSINESS IN CALIFORNIA. APPROVED MARCH 22, 1905.

SECTION 1. Any superintendent, director, secretary, manager, agent, or other officer, of any corporation formed or existing under the laws of this State, or transacting business in the same, and any person pretending or holding himself out as such superintendent, director, secretary, manager, agent or other officer, who shall willfully subscribe, sign, endorse, verify, or otherwise assent to the publication, either generally or privately, to the stockholders or other persons dealing with such corporation or its stock, any untrue or willfully and fraudulently exaggerated report, prospectus, account, statement of operations, values, business, profits, expenditures or prospects, or other paper or document intended to produce or give, or having a tendency to produce or give, to the shares of stock in such corporation a greater value or less apparent or market value than they really possess, or with the intention of defrauding any particular person or persons, or the public, or persons generally, shall be deemed guilty of a felony, and on conviction thereof shall be punished by imprisonment in state prison, or a county jail, not exceeding two years, or by fine not exceeding five thousand dollars, or by both.

SEC. 2. All acts and parts of acts in conflict with this act are hereby repealed.

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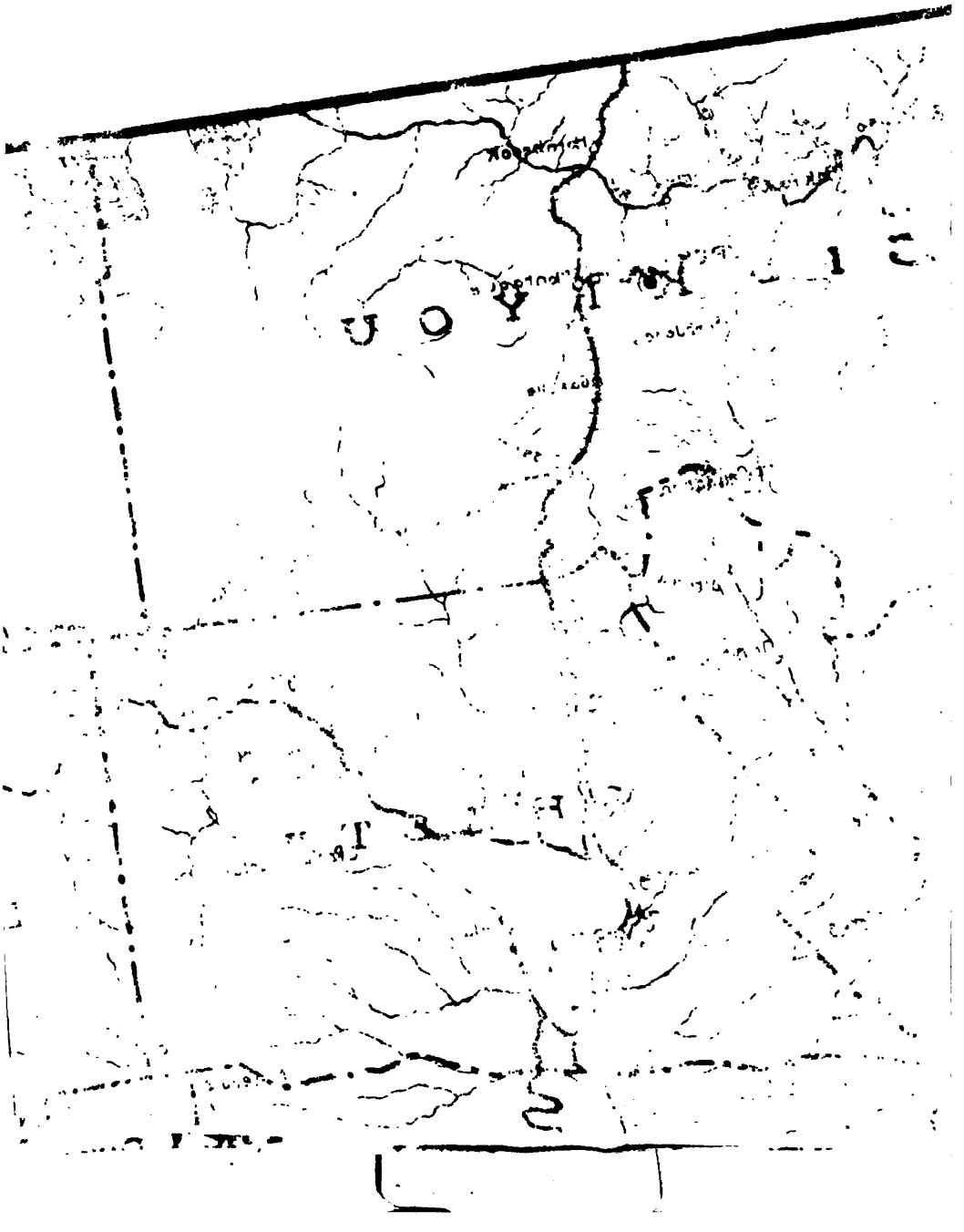

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